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THE DEPLOYMENT OF SCIENTIFIC EFFORT IN BRITAIN

IN his presidential address to the Royal Society on December 1, Sir Robert Robinson referred to the establishment of the Defence Research Policy Committee and the Advisory Council on Scientific Policy as the most interesting development in the relationship of science and administration during the past year, and as the fruition of insistent demands for scientific consultation at the highest levels. The Select Committee on Estimates in its Third Report for the Session 1946–47 (London : H.M. Stationery Office, 1947), on expenditure on research and development, not only made it clear that it looked to this development to secure in the future a better balance in the distribution of the nation's expenditure on research, but also to improve departmental administrative defects in the utilization and direction of research. This development has, however, been accompanied by uneasiness with regard to possible infringement of freedom of research by some form of planning or control, and to detrimental effects on the informal relations and collaboration between the Government and the Royal Society and other bodies.

This informality has been an important factor in maintaining the elasticity which has been a valuable feature of the nation's organisation for research in the past. Sir Robert Robinson has no anxiety on either of these points, and expressed his confidence that whatever gain in efficiency and co-ordination might be secured under the new arrangements, they would not lead to over-organisation or jeopardize the essential conditions of creative scientific work. On the other hand, there is a section of opinion which looks to the new developments to provide the essential framework of general control which will ensure that no important field of research of national interest is neglected, and that the broad distribution of the nation's resources of trained man-power, equipment, materials and finance for research is in reasonable balance so far as it is possible to judge.

What is in debate at the moment, however, is the limits to which such planning and control can extend. It is not seriously suggested that there is in Great Britain any real wish that the Government would interfere with the free development of fundamental research. There is every reason for believing that the Government as a whole recognizes the vital importance of such research, and that while seeking to ensure that research is adequately endowed, its great leaders will still be able to choose and pursue their own objectives and lines of work.

That being so, there remains a large field within which the general trend of the nation's research effort may be guided or planned, at least on broad lines ; and the economic crisis, which has intensified the need for the wisest use and fullest economy of all our resources, has brought to the fore a question which was already under discussion, namely, how far the methods of attack on urgent objectives adopted during the War, and generally known as 'operational research', can be applied in the present emergency, or even as a regular feature of our peace-time system.

It has been suggested, for example, that Cabinet planning bodies such as that presided over by Sir Guy Powden, and the Advisory Council of Scientific Policy, may be regarded as operational research sections established at a strategic level in the economic field. As the situation develops, such different bodies may find a common meeting-ground for the exposition of the major economic, scientific and administrative problems which have to be taken into consideration in a peace-time strategy.

Such a conception consorts with that of operational research as scientific management; but Prof. J. D. Bernal's contribution to the discussion at the Dundee meeting of the British Association showed that he wishes the principle to be applied at the highest level of planning authority. He proposed that the technique should be used to determine scientifically the highest priority, in accordance with Prof. Blackett's general principle, and that our effort should be concentrated on those problems which combined the greatest need with the greatest possibility of rapid achievement. The most obvious priorities are coal, steel, building and agriculture; but others, such as transport, distribution and the utilization of chemical wastes, may prove equally important, and the technique of operational research should be used, in his opinion, to find out what has to be done, to verify the success of the operation and to modify its conduct.

These are all in the nature of economic planning, but physical research is required wherever materials and techniques have to be transferred from their present use to a new one. A redistribution of the nation's research effort of the order of that proposed by the Association of Scientific Workers must inevitably pose a large number of problems in research as well as in organisation. Already, however, the redistribution outlined in the White Paper on "Capital Investment in 1948" (Cmd. 7268. London: H.M. Stationery Office, 1947. 6*d*. net) involves some repercussions on the research effort in Great Britain, and in itself raises afresh the whole question of the limits within which economic planning and control are feasible or wise.

The limitations of what is often called 'physical' control are one of the most striking lessons of the last two years, and central detailed control of complex economic relationships is now recognized as much more difficult than was at first realized. This is not to say that the attempt at economic or political planning should be wholly abandoned, although Prof. D. H. Robertson, in his presidential address to Section F (Economics and Statistics) at the Dundee meeting of the British Association, went far towards indicating this. It was not suggested that the task of planning cannot be accomplished by methods of freedom and tolerance; but it was suggested that a real effort should be made to establish, experimentally if need be, as a matter of urgency, the limits of planning. If progressive direction and political democracy are to work together, the main method must be, first to secure the maximum possible dispersion of decisions, and then to influence such decisions by indirect, persuasive measures, such as taxation and credit control.

These doubts as to the value of planning in practice, despite general agreement with it in principle, are largely the outcome of experience, often personal, of the wastefulness of physical controls in man-power. Multiplicity of forms, interminable details and a lack of common sense have in many cases led to hopeless inefficiency, frustration and exasperation. To eliminate the maximum amount of friction rather than to engender it, and to secure the maximum amount of consent and support for proposed administrative action is a primary and urgent need; this is one of the outstanding characteristics of that technique we describe as operational research, and one reason for its striking success.

It was a main purpose of Sir Hubert Henderson's Rede Lecture last May on "The Uses and Abuses of Economic Planning" to direct attention to the danger that on the strength of the misleading analogy of our war-time experience, planning may be regarded as a magic talisman by which those difficulties can be charmed away. That warning is equally valid for operational research, which, like planning, needs much hard thinking before it can be applied effectively to meet the needs either of the economic crisis or of a normal peace-time economy. Sir Hubert Henderson did not combat the view that we must have more State intervention and direction in our economic life than we had before the War; nor did he dispute the need for quantitative programmes for such purposes as the regulation of imports. He insisted, indeed, on the importance of the Government computing as precisely as possible the calls which its programmes for housing, schools, generating stations, etc., will make on man-power, materials and productive capacity; and the White Paper on capital investment indicates that to some extent the Government has accepted the view that it is desirable in the interests of economic balance to restrain within moderate limits the amount of long-term investment work that is set on foot during the next few years. But Sir Hubert Henderson does not agree that there are equally good reasons for slowing down the work of renewing and modernizing industrial plant; and although on this point the White Paper is vague, it seems clear that the shortage of steel will considerably retard the re-equipment and development of industry during the next few years.

This is the feature of the White Paper that is most disturbing. Inevitable as restrictions may be, the repercussions on industrial efficiency and even on our export programme may be very serious. Considerations advanced by Sir Hubert Henderson show the practical impossibility of any detailed planning of the restrictions so as to avoid impeding the expansion of particular branches of industry which will contribute most rapidly to industrial recovery in Britain and restoration of the balance of trade. It may be doubted whether even the most brilliant application of the methods of operational research could do much here to elucidate the uncertainties which surround new industrial development arising from scientific research even in normal times, and one great risk inherent in the new restrictions is that potential new advances may be stifled at birth for lack of laboratory

and small-scale plant facilities, so that the opportunity is missed and our competitors overseas are first in the field.

Sir Hubert Henderson believes that over the greater part of our economic system quantitative programmes cannot play the part of 'directives to action' for purposes of increasing prosperity; but he does not believe that large-scale readjustments will be made smoothly or satisfactorily if they are left to the forces of supply and demand, unaided and uncontrolled. Programmes must never be an excuse for evading the crucial questions of costs and prices and competitive efficiency. What was challenged by Prof. Robertson, however, was the practicability of maintaining the distinction made by Sir Hubert Henderson between the Government sector of economic life and the private sector, or that made by Sir Oliver Franks between the strategy functions of Government and the tactical functions to be performed by industry and by labour. He questioned the feasibility of even the minimum of planning and control suggested by Sir Oliver Franks, and whether there is any real distinction between democratic and totalitarian planning.

Prof. Robertson suggested frankly that we should work towards the restoration of the price system as the only way of directing labour in a free society, and incomparably the most effective in any society; and in urging this he is in line with a marked trend of opinion in favour of using indirect persuasive measures in place of the detailed control which in practice proves so dangerous and so irksome. It is true that the great risk here is to the method of agreement stressed by Sir Oliver Franks; but although the task of devising a system for central planning and control in time of peace which does not conflict with democratic ideas and habits may be difficult and dangerous, that is no reason for not making the attempt. Sir Hubert Henderson does not challenge the correctness of Sir Oliver Franks' view that the decisions of Government must be kept general in scope and limited in number, determining merely the broad pattern of the economy and the consequent programmes to be carried out by industry and commerce; but he emphasizes the disturbing influence of external conditions and world trade generally.

Now the scientific investigator entering a new field cannot attempt to isolate all the unknown factors in a problem at the start. He must proceed from stage to stage, as he enlarges the boundaries of his knowledge. To abandon the attempt to order what is within our control because we cannot deal with what is at present beyond it would be the death knell of scientific advance. If the technique of planning is used in economic affairs in accordance with the scientific method, there can be little fear that it will be over-strained; but its use does demand a large measure of public understanding and an attempt to clear away the false impressions which extravagant claims have created in the past. Only so can we ensure that Government decisions are criticized honestly and constructively, and that the way is prepared for the public consent which is an essential element for their success in a free society.

To the extent to which the technique of operational research contributes to this process by extending the boundaries of public discussion and understanding, its adoption is to be welcomed, at the lower levels as well as at the highest. None the less, unless the points of application are wisely chosen, there is danger that false hopes will be raised and the new method discredited before it has been fairly tried. It may be, and probably is, true, as Prof. Bernal has suggested, that thousands of scientific workers and engineers are being used in a wasteful manner or for purposes of secondary importance both in industry and in the Service research departments; but 'operational research' will not necessarily determine the best distribution. Research in the true sense may be required to assess some of the targets and to decide on which the expenditure of man-power will be most worth while; this will be one of the tasks of Sir William Stanier's panel under the new Committee on Industrial Productivity. But decisions must ultimately be matters of human judgment, in which much besides technical and scientific factors has to be pondered.

EXTERIOR BALLISTICS OF ROCKETS

Mathematical Theory of Rocket Flight

By Prof. J. Barkley Rosser, Dr. Robert R. Newton and Dr. George L. Gross. Pp. viii+276. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22*s.* 6*d.*

THIS book is the official final report concerning the work done on the exterior ballistics of finstabilized rockets at the Allegany Ballistics Laboratory during 1944 and 1945. It is of importance as containing the only serious treatment of the mathematical theory of rocket flight so far published. Much of the material has been known to rocket ballisticians for a considerable time, but has, for security reasons, remained unpublished until now. The authors make generous acknowledgment of the work of their predecessors in Great Britain and the United States; but, because of official regulations, they cannot mention individual contributions. It therefore seems fair to record that in Great Britain the theory was well advanced, and in a form suitable for application, before the outbreak of war, the foundations having been laid as early as 1936 by W. R. Cook and other members of the Rocket Section of the Ballistics Department at Woolwich. Since 1939, work on rocket development has proceeded rapidly both in Great Britain and the United States, and information has been freely exchanged; to this development the authors have made important contributions.

The book contains five chapters and five appendixes. In Chapter 1 the equations of motion are formulated. As Nielsen and Synge have shown (*Quart. Rev. Appl. Maths.*, 4, 201; 1946), even in the simpler case of shell fired from guns, considerable care has to be taken if this is to be done consistently. For a rocket there are added difficulties due to the decrease in mass caused by the expulsion at high velocity of the burning gases from the nozzle. For these and other reasons the principles of the con-

servation of linear and angular momentum require careful enunciation, and over-simplified treatments of the problem can lead to erroneous results. The authors avoid such pitfalls by a careful examination of the equations governing the motion of systems of particles of changing mass. The equations of motion, as derived, hold for unrotated rockets only; the modifications necessary to cater for a slow axial spin are indicated briefly and are valid if the spin is sufficiently low to avoid all gyroscopic effects.

The chief objects of rocket ballistic theory are to give methods which can be used to calculate (1) the trajectory of a perfect round fired under ideal conditions, and (2) the deviations from this mean trajectory, due to various disturbing factors, of a group of rounds fired in similar circumstances. Of these two problems the second is the harder. The deviations which occur are due to asymmetries of design and functioning and, being generally of a random character, produce a dispersion about the mean trajectory which is larger than that of shell fired from guns. The greater part of this dispersion is usually attained before the propellant has ceased burning, so that deviations during the succeeding part of the trajectory are of lesser importance. In Chapter 3 the authors obtain solutions of the equations of motion which are valid during the burning period under certain simplified assumptions such as constant acceleration and absence of damping, and in Chapter 2 they examine the effects of the conditions existing at 'all-burnt', and of other factors, upon the motion throughout the remainder of the trajectory. These solutions can be used to estimate the dispersion when numerical values of the parameters describing the asymmetries are known. For the unrotated rocket the chief factor causing dispersion has generally been thought to be malalignment of the direction of the thrust. The dispersion observed in trials has usually, however, been much larger than that predicted by the theory when this malalignment is taken to be the same as that of the nozzle axis. The reasons which have been advanced to account for this discrepancy, and the other factors which contribute to the dispersion, are fully and completely discussed in an unbiased manner and are illustrated by numerical examples from actual trials. In this connexion, the reviewer has only the minor criticism to make that the term 'dispersion' is sometimes used to cover deviations which are systematic and not random.

In Chapter 4 the effect of 'tip-off' at launch from the launcher (projector) is considered, and in Chapter 5 the 'rocket functions', in terms of which the solutions of the equations are expressed, are described and fully tabulated. These functions are related to the Fresnel integrals but, being monotonic, are more suitable for interpolation. The two basic functions $\mathrm{rr}(x)$ and $\mathrm{rj}(x)$ are essentially the functions $(K \pm H)/\sqrt{\pi}$ introduced by Lash Miller and Gordon (*J. Phys. Chem.*, 35, 2785; 1931).

The book is written in a clear and lucid manner throughout, and is intended not only for the trained man of science and rocket ballistician—for whom it will be invaluable—but also "for the person with little scientific training who is interested in what makes a rocket go". The latter type of reader will no doubt wish to omit the more mathematical parts of the book, but the introductory remarks at the beginning of the sections and the many numerical examples will give him a clear picture of the principles and peculiarities of rocket flight. R. A. RANKIN

ATOMIC ENERGY

Atomic Energy in Cosmic and Human Life

Fifty Years of Radioactivity. By Assoc. Prof. George Gamow. Pp. xi + 161 + 5 plates. (Cambridge: At the University Press, 1947.) 7*s*. 6*d*. net.

IT is a bitter commentary on man's failure as a social being that any mention of atomic energy arouses feelings, not of pleasurable anticipation of a boon conferred, but of dread of an approaching and scarcely to be escaped evil; and that an artist, commissioned to design a book-jacket for a treatise on the subject, should have been inspired, as John Hookham has been by the book that lies before us, to produce an allegorical picture of the fine flower of civilization already half-eclipsed by an obviously deadly and hideous growth. There is a certain bitter irony in the fact that the release of at least a small fraction of the enormous energy lying dormant in the heart of matter, which from one point of view represents the highest peak achieved by the modern scientific age, should also present the greatest single threat to its continued existence.

In spite of the pictorial warning of the dust cover, however, the reader who opens this little volume will find little either to increase or allay his fears. Prof. Gamow, in spite of the title, is much more interested in the achievement than in its possible social consequences whether for good or for evil. That atomic energy can be released explosively, and that it may ultimately be used constructively, are facts which he notes among the many other interesting properties of the atom; he even goes so far as to make some half-humorous suggestions as to how the thing can be done. In the main, however, he is concerned to give an intelligible account of the development of atomic research during the fifty years which have elapsed since the spontaneous release of atomic energy fogged a packet of photographic material in the drawer of Becquerel's desk, and J. J. Thomson discovered the electron.

It is a story well worth the telling; and we may congratulate ourselves that Prof. Gamow has undertaken the task. Prof. Gamow, as many readers of *Nature* will know, has the enviable art of making abstruse matters appear not merely intelligible but even actually entertaining. This is due, in part, to his own very obvious delight in the ideas which he is trying to convey, and in part, no doubt, to a certain naïve and rather charming humour, which bubbles up in his text in the form of little asides, quaint anecdotes and crude little sketches, inserted for no reason more obvious than that it amused the author to draw them. In the main, however, his success is due to the fact that he lives on such familiar terms with his subject that he can afford to treat it with a certain friendly disrespect, and has no hesitation in dragging it down within the comprehension of his prospective readers. This is all very refreshing. There is no reason why a scientific book should be either portentous or dull. One caveat, however, might be taken. It is not amusing to christen 'one million electron-volts' a 'crocodile'. Nothing can be less funny to an outsider than a private family joke, even when, as in this case, its retailer takes the trouble to explain it at length. When, as in the case of the 'crocodile', it is repeated on page after page of the text, it is apt to become somewhat annoying.

Prof. Gamow has divided his book into three sections. In the first, under the title of "Modern

Alchemy", he sketches the development of nuclear physics, from the early discoveries of radioactivity to the latest available publications. In this chapter he, as it were, sets the scene for the final *dénouement* and introduces us to the leading characters. The sketch is, of course, far from complete as a history of fifty years of scientific effort; but Prof. Gamow has a good eye for the main points, and it is surprising how much exact information he has succeeded in compressing into these fifty-two pages. In the second section, "How the Stars use Atomic Energy", Prof. Gamow discusses in considerable detail the cosmic aspects of atomic energy, and the processes by which the energy of the universe, assumed to have been originally all in nuclear form, is being steadily transformed into the radiant light and heat from which all our sources of terrestrial energy are ultimately derived. Much work has recently been done on this subject, and the main outlines and some of the details are now becoming sufficiently clear and certain; and this summary of the present position is very welcome. Few writers on the cosmical aspects of physics can avoid speculations, such as those which we enjoyed so much in the works of Eddington and Jeans, about the birth, progress and possible end of the universe, and Prof. Gamow is certainly not of their number. One may say that his account of the matter seems quite as convincing, and just as fascinating, as those of his predecessors in the field.

In the final section, "How can Man use Atomic Energy?", the author gives an account of the physical principles underlying the purposive release of atomic energy, whether for destructive or for constructive purposes. Prof. Gamow's mastery of the subject is evident in every page of the text, though in fact he reveals nothing which was not implicit in Dr. Smyth's official report. In these times, when a scientific author must write with one eye on his readers and the other on the police, more could not be expected. However, the official report was so informative on the purely scientific aspects of the problem that Prof. Gamow has quite enough material available for his particular purpose. If there is one portion of the book where we might have hoped for rather more guidance from the author it is in the very brief concluding paragraphs on the peaceful uses of atomic power, on which a considerable amount of information has recently been released in the United States. Possibly Prof. Gamow considers that these economic and technical matters are outside the scope of his present book.

Although the book is entertainingly written, and entirely non-mathematical in character, it is a very serious attempt to present as complete a picture as possible of the atomic energy problem in its scientific aspects, and demands and deserves the close attention of the reader. Prof. Gamow has not shirked the undoubted difficulties of the subject, though he has taken great pains to alleviate them by numerous analogies, illustrations and graphs. What that somewhat hypothetical individual—the general reader—can make of it all must be left for him to discover. He is not likely to find a pleasanter or more competent guide to the subject. Any student about to begin a course on nuclear physics should certainly read the book in order to learn what it is all about; while any student who has just completed such a course might equally profitably read it in order to discover what it has all been about. Many physicists and other scientifically minded people, who realize that during these last few strenuous years they have been unable to keep abreast of this latest efflorescence of science, will thank Prof. Gamow for providing them with this opportunity of bringing their knowledge up to date. The more widely a knowledge of the potentialities for good or evil of this latest addition to our power resources is disseminated the better.

J. A. CROWTHER

DAY BY DAY ON SKOKHOLM ISLAND

Letters from Skokholm

By R. M. Lockley. Pp. x+244. (London: J. M. Dent and Sons, Ltd., 1947.) 15*s*. net.

THE letter form of composition has many advantages, particularly in describing the day-by-day happenings of a rural, or in this case an island, life. Mr. Lockley has written before of islands, and in particular of his own island of Skokholm off the Pembrokeshire coast of Wales; but he has by no means exhausted the interest and fascination of the subject, and we are glad he has recast the letters originally addressed to his brother-in-law, John Buxton, when a prisoner-of-war, and made them into a book.

In the first letter the author discusses why he went to live on Skokholm and the joys of simple living. He continues with various subjects, such as the history of the island and its occupation by man, beasts and birds. It was early populated by rabbits. There are documents dating back to 1324 which show how numerous they must have been. In the winter of 1387–88, 3,120 carcases were brought from the islands of "Schalmey, Schokolm and Middleholm".

Since those days rabbits have continued to flourish on the islands and all attempts to exterminate them have failed. In 1936 Mr. Lockley, having tried trapping, ferreting, snares and nets without any really marked effect, resorted to a virus disease which it was hoped would be 100 per cent effective, but it was not. It had little or no effect.

The best results were achieved with 'Cyano-gas' and the rabbits were really reduced, enabling the author's farming operations to be conducted with much more success.

One of the most interesting letters is that which tells of an old cow grey seal coming ashore on an early October day to give birth to her calf. For four days she "did not stir from beside her child, which she fed at least three times a day, probably oftener. To watch the calf suck the retractable breasts, and to see Clementina"—as the mother had been dubbed—"paw and fondle her lovingly, very humanly, was a happy sight."

Mr. Lockley says that he has found grey seal calves dropped here any time between late July and late December, whereas on the north-west of Scotland calving seems to be confined to September, October and November.

The author's letters cover a wide field, including bird migration and trapping of the migrants for identification and ringing purposes; a visit to Grassholm and its gannets; the Manx shearwaters that throng in such numbers to Skokholm; and many other things. A brief review can but hint at his topics, but reference must be made to the admirable illustrations executed by Mr. Charles Tunnicliffe, which are illustrations in fact as well as in name.

F. PITT

SCIENCE AND POLITICS

By D. W. BROGAN

Professor of Political Science, University of Cambridge

NO one could complain that the nineteenth Riddell Memorial Lectures in the University of Durham are lacking in topicality*. The terrifying efficiency of science, the terrifying inefficiency of politics, make, in combination, probably the most difficult and almost certainly the most urgent problem on the world's agenda. For much of the pressure of contemporary events, much of the strain that the whole world feels and wilts under, comes from the knowledge that the human race has set itself a problem which it may quite possibly prove to be unable to solve. We are faced, in a far truer sense than we were in 1914, with the possibility of a "war that will end war".

This problem is present in Prof. Ritchie's mind and it gives an especial urgency to the general problem that he is discussing, but his theme is not just the "control of the atom bomb". It is the wider theme of the role of science (which, of course, means of men of science) in the modern world and their relationship with the modern State.

It is also the theme of the meaning of the word 'science' in political discussion. Prof. Ritchie is right in linking the two problems, for the discussion of the first is clouded and often made pointless by ambiguity about the second. Faced with the immense power for good and for mischief that modern science puts into the hands of the modern State, the man-in-the-street (including the man-in-the-street who spends his working days in a laboratory) is bewildered and indignant. If he is a scientist man-in-the-street, he is alarmed at his own moral responsibility and tempted to think that the evil comes from letting the control of the scientific resources of the world, or of his own country, fall into wrong, that is, unscientific hands. So he dallies with the dream of a political society in which power and responsibility are united in the same hands. Since the world can be destroyed by men of science, why should not the power to save the world be put into their hands? Sometimes this hankering after a society 'scientifically' controlled is merely a revival of the old dreams of Platonic guardians or H. G. Wells' "Samurai". More commonly, to-day, it is based on a belief that immense possibilities for good are being thwarted and immense possibilities for evil being created by rulers who, neither by training nor by interest, understand the world that science has so thoroughly upset.

As Prof. Ritchie suggests, this dream is often given a local habitation and a name in the U.S.S.R.; and, as Prof. Ritchie also suggests, this dream is only a dream. In the Soviet Union, men of science *are* privileged people—like ballet dancers. They are not rulers and, so far as we know anything of the distribution of power in Russia, there is no Russian equivalent of Sir Stafford Cripps, no political ruler who has had a first-class scientific education. It is perhaps worth noting that this dream of a land where science is taken seriously is not new, and the country to which British men of science looked enviously, a generation ago, was Germany; the proof of the superior regard of an enlightened State for science was the Kaiser Wilhelm Institute in Berlin. There is, that is to say, no necessary relationship between a 'right' political organisation and a low regard for science. The Prussian army was once described by an optimistic admirer as "science in a Pickelhaube". Nor is there any necessary connexion between the man of science and a given attitude to politics. If most British, French and, probably, American men of science are 'left', that is due to social and historical conditions in their countries, not to any inherent bias due to a scientific training. Political credulity is quite compatible with a very high degree of scientific accomplishment, as the case of Germany shows. When we say, to-day, that a world so largely remade by science calls for 'scientific government', and by that mean a government by scientists, we are begging a great many questions. We are assuming that there is a unified class of 'scientists' and that this class has an identifiable and uniformly admirable attitude to politics. These things are to be proved, not assumed.

Prof. Ritchie raises, too, the question of the fitness of the man of science as such for political life. It is a question that might be further developed with great profit. It is often confused with the question of the desirability of having a great number of people in politics who have had a scientific education. The concealed assumption in arguments on these topics is that the man of science of the first order has something especially valuable to contribute to politics, and that the way to contribute it is for him to become a politician. The first proposition is, I think, indisputable. But it does not mean more than that in the fields in which the man of science is an expert he should be able to make his opinion heard, that there should be no danger of only one group or individual being heard, that the highest level of relevant public opinion in the scientific field concerned should be given all facilities for influencing general public opinion (including the public opinion of politicians).

It is also desirable that projects calling for a high degree of scientific expertize be planned by people who know how science does, in fact, progress. Prof. Ritchie points out that there is no agreement on how science *does* progress, though he has no doubt that the real principle is that "the wind bloweth where it listeth". In the case of technology, Prof. Ritchie both accepts and welcomes far more general control of experiment, far more general imposition of ends than we have been accustomed to. He accepts these limitations less, one might guess, because he thinks that this is bound to promote technical progress, than because he sees the dangers of uncontrolled 'progress', of technical advances made without its being anybody's business to question or define the 'good' of such progress.

But Prof. Ritchie sees another danger in the credulous and indeed superstitious acceptance of the magical claims of science. That what the man-in-the-street often means by science is an unintelligible magical power is suggested by the way the popular Press treats any real or alleged scientific achievement, by the low standard of critical reporting in this field and by the fine, general confusion of very different kinds of scientific technique which is the attitude of millions who yet smile pityingly at the superstitions of their ancestors. What is admired or worshipped is not scientific methods but a mysterious power. "In short, to be scientific is to be powerful; to possess the 'mana' or power of the witch doctor so much admired and feared by primitive man." There is good reason to fear that a popular decision to put

* "Science and Politics", by Prof. A. D. Ritchie. (University of Durham, Riddell Memorial Lectures.) (London: Oxford University Press, 1947.) 2s. 6d. net.

power into the hands of 'scientists' would be far from making for general progress or even safety. Scientific demagogues, scientific revivalists, are quite serious possibilities. Indeed, there is a danger that if real or fictitious scientific attainments were a way to political power, the last state of science (and politics) might be worse than the first. For both science and politics are very jealous taskmasters. It is almost certain that no man of science of the first order could keep his scientific rank and live a full political life at the same time. Indeed, all the pressures of both ways of life are against such a combination. It is not only that science changes rapidly, but that politics is more and more a full-time job. It is not a matter of a few interventions in debate, of a few deputations to ministers, of service on an occasional royal commission. With the great modern extension of the powers of the State, the duties of an active politician have more and more become incompatible with the successful pursuit of any other career. It is a problem that affects more people than men of science. It is, for example, doubtful if even a university constituency to-day would put up with a member doing so little direct political work as Edinburgh agreed to tolerate in the case of Macaulay. If it be said that this is only true of democratic countries (in the Western sense), it can be replied that it does not matter how a great man of science fritters away his time, whether in democratic or dictatorial politics; the price of power is the same—eternal vigilance and a consequent neglect of his primary claim to power, his scientific excellence.

It is quite another matter to suggest ways in which the highest scientific opinion should be given opportunities of access to an effective sounding board. Perhaps there should be more university Members of Parliament, more men of science promoted to the House of Lords, more weight given to the considered judgment of organised bodies like the Royal Society; but this is far from the rule of the State by men of science. It is a truth, possibly a sad truth, that the rulers of a State are always politicians, and if they have been men of science, the decision as to whether they have done well or ill by leaving science for politics depends on the degree to which their transfer of allegiance has been a loss to science or a gain to politics; and that in every case is an individual judgment.

Carefully and ingeniously distinguishing between various kinds of scientific technique, Prof. Ritchie takes up the claims of the so-called 'social sciences'. It is true that this ambiguous term is often used merely to placate contemporary taste, to give the impression that the economist or historian or anthropologist or statistician is doing *real* work comparable in importance and in method to work on the atom bomb or on bacteriological warfare or on new applications of nylon or penicillin. But this confidence trick does neither the physical nor the social sciences much good. It is, perhaps, in a natural reaction against this trick that Prof. Ritchie scales down the claims of the social sciences. "The rules already formulated are generally only assertions of what happens for the most part, not of what happens always; they resemble the looser rules of biology, not the stricter ones of physics." This is true, but the application to social problems even of "the looser rules of biology" is highly desirable. Prof. Ritchie thinks that "if there is to be social science which produces control of human beings, legitimate yet in some ways comparable to that control of physical objects which is the fruit of physical science, should it not be a science of persuasion?". It should, but one drawback of a society largely governed by persuasion is that persuasion becomes an end in itself; winning over the jury, the House of Commons, the electorate is all that matters. Such a society overvalues the arts of persuasion, and the skilled persuader is often genuinely angered when exterior forces refuse to be persuaded as a mass meeting can be, or when a popular vote repealing arithmetic or abolishing rain on holidays proves ineffective. It is in breeding a habit of respect for established truths that a scientific education, or any rigorous education, is useful to the State and to the would-be statesman. 'Social science' is doubly useful in that it can or should breed respect for the awkward fact and that it brings to the notice of the ruler the existence of the awkward fact. Prof. Ritchie goes too far, surely, when he writes "there is one genuine improvement to be recorded of the last 150 years that can definitely count as scientific: i.e. the collection and use of social statistics". That the growth and improvement of statistical methods is one of the most valuable conquests of the social sciences is undoubted. But statistics as such may be mere information; a statistician may have no very helpful ideas about what questions to ask or any clear idea of what to do with his own answers. Social scientists must continually ask themselves, as Prof. Lynd recommends them to do, "knowledge for what?". Statistical questions and answers are often about categories which must, so far as is humanly possible, be defined before the statistical question can be usefully put. Mere knowledge of numbers of Hindus and Moslems in India is barren unless we have some idea of what we mean by Hindus and Moslems. Surely another great gain of the past 150 years has been an extension of sympathetic curiosity about human society, so that we do not now think of China or India or even of savage societies exclusively in our own terms? We do know a great deal more about the mechanisms of other societies and indeed about the mechanisms of our own society than was known 150 years ago—or much later. Anthropology and sociology have not been merely efforts in cataloguing (though many books in these fields have been that and nothing more).

Primitive as it is, social science is not as primitive as it was. In its methodology it is not like physics or even the biological sciences, and its results are less certain, less general, less permanent. But into the study of human affairs something of the spirit of the exact sciences has been imported, and one fairly well established result has been the understanding of the great differences which there must be between the exact sciences and the would-be sciences of social organisation and human behaviour. The acceptance of as much of the spirit of the exact sciences as human frailty and the character of the materials permits, the acceptance of the idea that an exact, infallible, quasi-mathematical science of society is impossible, these results are not everything, but they are something. If Prof. Ritchie's lectures devote more space to eradicating error and exposing false analogies than to laying down the lines of a scientific politics, his time and his readers' time has not been wasted, since the weeds tend to grow up again, and since the new Riddell Lectures with great skill bring home the nature of the problem, both to the reader who thinks that the creation of a social science is easy and to the reader who thinks that it is superfluous.

EDIBILITY OF THE EGGS OF BIRDS

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IN a previous communication[1], a preliminary account was given of observations and experiments on the relative edibility of the flesh of birds. Full details of this research have now been published elsewhere[2]. During the past two years, this work has been extended to an investigation of the relative edibility of birds' eggs. Final results of the inquiry, which is still in progress, will not be available for some time; but since, with the exception of a paper by C. F. M. Swynnerton published in 1916[3], the subject appears hitherto to have remained almost unexplored, it would now seem appropriate to summarize the new observations and to indicate certain conclusions to be drawn from them.

The bulk production and purchase of various foodstuffs (including eggs) during the War led to a widespread use of tasting panels (together with other methods for the assessment of quality) for the purposes of standardization and grading. At the Low Temperature Research Station, Cambridge, a tasting panel was already in existence in 1936[4]; and I take this opportunity of expressing my indebtedness to the three members of this panel—Dr. J. Brooks, Mr. H. P. Hale and Dr. J. R. Hawthorne—whose skill and experience have made possible the reliable assessments of palatability which form the basis of the present inquiry. Sincere thanks are also due to the Superintendent of the Station for allowing me storage and many other facilities in his Department.

The method of assessment was similar to that used in routine examination of fowls' eggs. Each sample was tested in the form of a scramble, prepared over steam, a numerical score being awarded on a scale ranging from 10·0 (excellent flavour) to 2·0 (inedible). In general, seven or eight species were tested at one session. Members of the panel were in all cases unaware of the identity of the samples to be examined (except in the case of a fowl's egg used as a control); and they recorded their results independently. The majority of species listed below were examined on two occasions by each taster, so that in general the mean edibility rating for a species is based upon six independent assessments. Eggs of eighty-one species, belonging to eleven orders and thirty-five families, have now been examined. In the following list these are arranged in order of palatability.

GROUP A (RELATIVELY PALATABLE)

Domestic fowl	8·8
Coot (*Fulica a. atra* Linn.)	8·3
Moorhen (*Gallinula c. chloropus* (Linn.))	8·3
Lesser black-backed gull (*Larus fuscus graellsii* Brehm)	8·3
Kittiwake (*Rissa t. tridactyla* (Linn.))	8·2
Herring-gull (*Larus a. argentatus* Pont.)	7·9
Common tern (*Sterna h. hirundo* Linn.)	7·8
Fulmar petrel (*Fulmarus g. glacialis* (Linn.))	7·7
Greater black-backed gull (*Larus marinus* Linn.)	7·7
Guinea-fowl (*Numida m. meleagris* (Linn.))	7·6
Razorbill (*Alca torda britannica* Ticehurst)	7·6
White-naped crane (*Grus vipio* Pall.)	7·5
Chaffinch (*Fringilla coelebs gengleri* Kleinschmidt)	7·5
Hedge-sparrow (*Prunella modularis occidentalis* (Hart.))	7·5
Partridge (*Perdix p. perdix* Linn.)	7·3
Lapwing (*Vanellus vanellus* (Linn.))	7·3
Spur-winged plover (*Lobivanellus lobatus* Lath.)	7·3
Stock-dove (*Columba anas* Linn.)	7·3
Jackdaw (*Corvus monedula spermologus* Vieill.)	7·3
Spotted flycatcher (*Muscicapa s. striata* (Pall.))	7·3
Domestic turkey	7·2
Red-legged partridge (*Alectoris r. rufa* (Linn.))	7·2
Bullfinch (*Pyrrhula p. nesa* Math. and Ired.)	7·2
Southern guillemot (*Uria aalge albionis* With.)	7·1
Great skua (*Stercorarius s. skua* (Brünn))	7·1
Rock-dove (*Columba l. livia* Gmel.)	7·1
House-sparrow (*Passer d. domesticus* (Linn.))	7·1
Common gull (*Larus c. canus* Linn.)	7·0
Dipper (*Cinclus c. gularis* (Lath.))	7·0

GROUP B (INTERMEDIATE)

Hobby (*Falco s. subbuteo* Linn.)	6·9
Cirl bunting (*Emberiza c. cirlus* Linn.)	6·9
Black-headed gull (*Larus r. ridibundus* Linn.)	6·8
Wood-pigeon (*Columba p. palumbus* Linn.)	6·8
Little owl (*Athene noctua vidalii* Brehm)	6·8
Kestrel (*Falco t. tinnunculus* Linn.)	6·7
White-fronted goose (*Anser a. albifrons* Scop.)	6·7
Carrion-crow (*Corvus c. corone* Linn.)	6·7
Magpie (*Pica p. pica* (Linn.))	6·7
Pheasant (*Phasianus colchicus* Linn.)	6·6
Domestic duck	6·6
Robin (*Erithacus rubecula melophilus* Hart.)	6·5
Rook (*Corvus f. frugilegus* Linn.)	6·3
Skylark (*Alauda a. arvensis* Linn.)	6·3
Catbird (*Dumetella carolinensis* (Linn.))	6·3
Sparrow-hawk (*Accipiter n. nisus* (Linn.))	6·2
Little tern (*Sterna a. albifrons* Pall.)	6·1
Eider (*Somateria m. mollissima* (Linn.))	6·0
Red-backed shrike (*Lanius c. collurio* Linn.)	6·0
Swallow (*Hirundo r. rustica* Linn.)	6·0
British jay (*Garrulus glandarius rufitergum* Hart.)	5·8
Long-tailed tit (*Aegithalos caudatus rosaceus* Mathews)	5·8
Blackbird (*Turdus m. merula* Linn.)	5·8
Greenfinch (*Chloris c. chloris* (Linn.))	5·7
Chiffchaff (*Phylloscopus c. collybita* (Vieill.))	5·7
Meadow-pipit (*Anthus pratensis* (Linn.))	5·7
Sand-martin (*Riparia r. riparia* (Linn.))	5·7
Capercaillie (*Tetrao u. urogallus* Linn.)	5·5
Song-thrush (*Turdus e. ericetorum* Turton)	5·5
Cowbird (*Molothrus a. ater* (Bodd.))	5·4
Tree-sparrow (*Passer m. montanus* (Linn.))	5·3
Yellow bunting (*Emberiza c. citrinella* Linn.)	5·3
Gannet (*Sula bassana* (Linn.))	5·3
Oyster-catcher (*Haematopus ostralegus occidentalis* Neum.)	5·2
Bar-headed goose (*Eulabeia indica* (Lath.))	5·2
Dabchick (*Podiceps r. ruficollis* (Pall.))	5·0
Turtle-dove (*Streptopelia t. turtur* (Linn.))	5·0

GROUP C (RELATIVELY UNPALATABLE)

Puffin (*Fratercula arctica grabæ* (Brehm))	4·8
Sedge-warbler (*Acrocephalus schænobænus* (Linn.))	4·7
Blackcap (*Sylvia a. atricapilla* (Linn.))	4·7
Lesser whitethroat (*Sylvia c. curruca* (Linn.))	4·5
Shag (*Phalacrocorax a. aristotelis* (Linn.))	4·4
Sandwich tern (*Sterna s. sandvicensis* Lath.)	4·3
Little crake (*Porzana parva* (Scop.))	4·0
Linnet (*Carduelis c. cannabina* (Linn.))	3·9
Ringed plover (*Charadrius h. hiaticula* Linn.)	3·8
Whitethroat (*Sylvia c. communis* Lath.)	3·8
Great tit (*Parus major newtoni* Prazak)	3·5
Reed-warbler (*Acrocephalus s. scirpaceus* (Herm.))	3·4
Blue tit (*Parus caeruleus obscurus* Prazak)	3·2
Eastern house-wren (*Troglodytes a. adon* (Vieill.))	3·2
Wren (*Troglodytes t. troglodytes* (Linn.))	2·0

An extensive series of experiments has also been carried out to test the preferences of small egg-eating mammals such as the ferret, rat and hedgehog. In each test, the experimental animal was offered a choice as between two egg-samples. On the basis of 454 experiments with rats, it has been possible to arrange the eggs of thirty-five species in their approximate order of palatability for these animals. With hedgehogs, 230 tests have provided a basis for assessing eighteen egg-species. Only 17 tests have as yet been made with a ferret, on eleven egg-species.

From this work it is clear that the eggs of various birds differ very widely in palatability to egg-eating mammals, as they do to man—all these animals showing unmistakable preferences or aversions for particular eggs. It appears also that the assessments by experimental animals are in fair agreement with the human palatability rating. This general agreement is very close for the ferret, and tolerably so for the hedgehog. Rats show wider differences, especially in their rating of various species considered as palatable or intermediate by man. For example, rats appear to class chaffinch, spotted flycatcher and hedge-sparrow as relatively unpalatable, while the bar-headed goose, magpie, dabchick and eider are given a high place in the series.

Similar *pairs* of egg-species offered to the various experimental animals afford a means of comparison, and show the following agreement or disagreement with the human edibility rating:

Experimental animal	Number of paired samples		
	Agreement	Doubtful	Disagreement
Rat	55	19	30
Hedgehog	23	7	10
Ferret	9	3	0

It is perhaps significant that agreement is closest for eggs of low-grade edibility. Thus, among eleven species below 4·9 (Grade C), no fewer than eight, namely, great tit, sedge-warbler, lesser whitethroat, linnet, eastern house-wren, blue tit, whitethroat and blackcap, appear (in the order given) at the bottom of the sequence for rats. Similarly, three of the four Grade C eggs offered to hedgehogs, namely, sedge-warbler, linnet and whitethroat, appear to be the least edible of eighteen species offered to these animals: puffin, on the other hand, is given a high place.

We may here note that Swynnerton's experiments[3], with a mongoose as taster, though not carried far enough to yield a graded sequence of egg-species, tend also to show some coincidence with the present ratings by man—where similar species are available for comparison. Thus, the eggs most acceptable to the mongoose included those of house-sparrow, bullfinch, greenfinch and moorhen; and those most repugnant, lesser whitethroat, great tit and wren. The above evidence on the preferences of four mammals therefore suggests that the sequence of palatability in terms of human preference may afford a provisional basis for the consideration of ecological and other aspects of the subject.

Eggs belonging to the few orders in which a considerable number of species has been examined show a very wide range of palatability. For example, Charadriiformes grade from 8·3 (lesser black-backed gull) to 3·8 (ringed plover); Passeriformes, from 7·5 (chaffinch) to 2·0 (wren). This wide intra-ordinal range appears to indicate that edibility in eggs may be largely independent of systematic status. A comparison of the various orders in this respect should be based upon a more extensive series than has at present been examined. Nevertheless, the following figures may give some indication of relative edibility within various groups:

Order	No. of species	Edibility range	Mean edibility
Procellariiformes	1	—	7·7
Galliformes	7	8·8 — 5·5	7·2
Gruiformes	4	8·3 — 4·0	7·0
Strigiformes	1	—	6·8
Charadriiformes	17	8·3 — 3·8	6·7
Columbiformes	4	7·3 — 5·0	6·6
Falconiformes	3	6·9 — 6·2	6·6
Anseriformes	4	6·7 — 5·2	6·1
Passeriformes	37	7·5 — 2·0	5·6
Columbiformes	1	—	5·0
Pelecaniformes	2	5·3 — 4·4	4·9

It might be expected, in the absence of contrary evidence, that the palatability of an egg would show some relation to that of the bird which laid it, and that an acceptable or repugnant flavour in the former might be a reflexion of palatable or distasteful properties of the parent. Indeed, it is true that some birds with high-grade flesh lay palatable eggs—as is notably the case with Galliformes, and with some Charadriiformes and Columbiformes. Similarly, in the oyster-catcher both eggs and flesh are unpalatable. Nevertheless, in general there is a wide discrepancy between the quality of the flesh and eggs of various species. Thus, the relatively distasteful common tern, jackdaw, and bullfinch lay palatable eggs. Conversely, many of the species the eggs of which are bitter and repugnant, including turtle-dove, little crake, ringed plover, yellow bunting, tree-sparrow, sedge-warbler and reed-warbler, are themselves good or excellent as food. Such divergences no doubt follow from the fact that while there is a general correlation between coloration and palatability, both for eggs (see below) and for birds[4], the coloration of the egg itself has no relation to that of the parent bird.

We have also to note that there is no close or obvious relationship between the food-habits of a bird and the flavour of its egg. For example, the eggs of many maritime or shore-feeding species such as kittiwake, common gull, herring-gull, lesser and greater black-backed gulls, common tern, great skua, razorbill, guillemot and fulmar petrel, are good in flavour and free from 'fishiness'. The same is true of others outside the series examined. Thus, as I am informed by Mr. G. A. Gibson-Hill and Dr. L. Harrison Matthews, the eggs of king (*Aptenodytes p. patagonica*), gentoo (*Pygoscelis p. papua*), jackass (*Spheniscus demersus*), macaroni (*Eudyptes chrysolophus*) and rockhopper penguins (*E. c. crestatus*) are quite palatable and without any unpleasant or fishy flavour. The last-named is described by Earle (in Murphy[4]) as "particularly fine and delicate in flavour". Similarly, Gibson-Hill and Matthews considered the eggs of black-browed (*Diomedia melanophrys*) and wandering albatross (*D. exulans*) very good eating and nearly as palatable as those of domestic fowl. Conversely, the eggs of some species (see below) which do not eat fish or feed along the shore yet have a more or less pronounced and unpleasant fishy flavour. This apparent lack of correlation between edibility status of the egg and feeding-habits of the parent is again illustrated by insectivorous species, which may have high-grade (spotted fly-catcher, dipper), intermediate (sand-martin), or low-grade eggs (sedge-warbler, reed-warbler, wren). Similarly, the eggs of mixed (seed and insect) feeders may vary widely: thus we have the palatable chaffinch and hedge-sparrow; the intermediate greenfinch and yellow bunting; and the unpalatable linnet and blue tit. It appears, therefore, that no simple explanation of distastefulness, in terms of food-derived deterrents, is admissible.

There appears to be a broad relationship between relative edibility and egg-size. The shell-length of the species so far examined ranges from 104·0 mm. (white-naped crane) to 14·0 mm. (eastern house-wren). The five most distasteful eggs, those of the wren, eastern house-wren, blue tit, great tit and reed-warbler, are all among the smallest tested, and range from 14·0 to 18·3 mm. Conversely, the twelve species heading the list as most palatable are mostly large eggs, ranging from 41·0 (common tern) to 104·0 mm.—seven of these species laying an egg larger than the domestic fowl's. This general correlation is apparent from the accompanying graph (Fig. 1), which shows the mean shell-length for species within various palatability-groups.

The relationship appears to hold even within the limits of several orders and families. Thus the gannet is rated at 5·3 as compared with the shag at 4·4 (the respective egg-lengths being 78·1 and 62·9 mm.); among Rallidæ, coot (8·3, 52·6 mm.) and moorhen (8·3, 44·4 mm.) are rated above the little crake (4·0, 30·4 mm.); among Ploceidæ, the house-sparrow (7·1, 22·5 mm.) is preferred to the tree-sparrow (5·4,

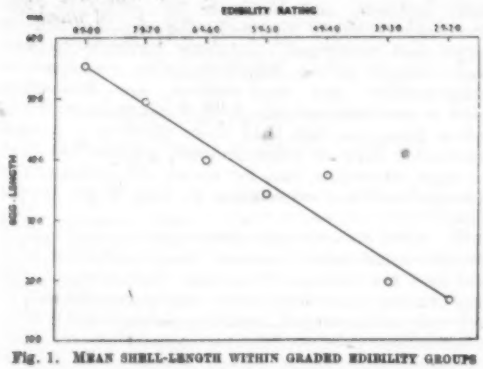

Fig. 1. MEAN SHELL-LENGTH WITHIN GRADED EDIBILITY GROUPS

19·3 mm.); among Hirundinidæ, the swallow (6·0, 19·9 mm.) to the sand-martin (5·7, 18·0 mm.). In several other cases, where the correlation throughout the group is less clear, it is found that the smallest egg is also the least palatable within its systematic group. For example, among three auks tested, guillemot (7·1, 81·5 mm.) and razorbill (7·6, 73·1 mm.) are more palatable than the puffin (4·8, 61·0 mm.); among three plovers, spur-winged plover (7·3, 50·0 mm.) and lapwing (7·3, 47·1 mm.) are both considerably larger and more palatable than the ringed plover (3·8, 35·7 mm.); among six species of gulls, the black-headed gull (6·8, 52·0 mm.) is both the smallest in size and lowest in edibility; among four Columbidæ, the turtle dove (5·0, 30·7 mm.) is again lowest for its group in both respects; while the same is true for six species of Corvidæ and six Fringillidæ, the jay (5·8, 31·7 mm.) in the former and linnet (3·9, 18·0 mm.) in the latter each showing the lowest figure for size and edibility within their respective families. In other groups, notably the terns and game birds, no such correlation is apparent; and on looking at the series as a whole, many outstanding exceptions are to be seen, both among the smaller and larger eggs. Thus, chaffinch, hedge-sparrow, spotted flycatcher, bullfinch and house-sparrow all lay small but palatable eggs graded between 7·5 and 7·1. Similarly, several relatively large eggs are outstanding as exceptions: the status of some of these, such as sandwich tern and bar-headed goose, is still subject to confirmation, since the freshness of the material available may have been in question. The remaining large unpalatable eggs are typically those of shore-living or maritime species such as puffin, shag, oyster-catcher and eider, in which the flavour of the egg is possibly tainted by the bird's diet.

There also appears to be a general correlation between the degree of conspicuousness of the egg and its palatability. Among nineteen species laying cryptic eggs in open situations, twelve occur in the palatable group (A) and five in the intermediate group (B), only two being recorded as unpalatable (C). Moreover, within Group A, cryptic eggs predominate at the head of the list, the first six species (omitting domestic fowl) all falling into this category. Twelve other species, in which non-cryptic eggs are covered by a cryptic parent on open nests, are also distributed (with one exception) in Groups A and B. Of the remaining fifty species, in which the eggs are more or less conspicuously coloured, and are not incubated by a cryptic parent, twelve are unpalatable, representing no less than 80 per cent of all species in Group C. The distribution of cryptic and non-cryptic eggs within graded palatability groups is shown in Fig. 2.

The various species rated as least palatable owe their distastefulness to a variety of unpleasant or foreign flavours: such terms as acid, rancid, soapy, sour, oily, salty, fishy, and bitter occurring in the reports of the panel. Eggs of the oyster-catcher (*Hæmatopus ostralegus occidentalis*) (5·2) are markedly different from those of all other eggs tested, being remarkable both for their strong aromatic odour and flavour, and for their wide individual variation: thus of three samples examined, the first was rated by the three observers at 4·0, 4·0, 5·0, each member of the panel recording a strong smell and taste of onions; the second, at 8·5, 7·5, 7·0, with normal or nutty flavour; the third, at 4·0, 4·0, 3·0, inedible, with a strong odour and flavour of hemp. Species rated as 'fishy' were numerous, those with a markedly rank and fishy smell and taste being shag (4·4), bar-headed goose (5·2), eider (6·0), sparrow-hawk (6·2), ringed plover (3·8), sandwich tern (4·3) and blue tit (3·3). It will be noted that some of these, such as the sparrow-hawk and blue tit, are not themselves fish-eaters.

But by far the most widespread and important distasteful quality is bitterness. This is a frequent attribute of eggs in the lowest palatability grades. In nineteen species this flavour was more or less pronounced (being noted in at least 50 per cent of tests on the species concerned). Fifteen of these bitter-tasting eggs were those of passerine birds: greenfinch, linnet, yellow bunting, tree-sparrow, meadow-pipit, long-tailed tit, red-backed shrike, sedge-warbler, reed-warbler, chiffchaff, common and lesser whitethroats, eastern house-wren, swallow and sand-martin. It will be noted that all these are small species, laying eggs between 23·0 and 14·0 mm. long. Moreover, the remaining four species recognized as markedly bitter, namely, ringed plover, little tern, little crake and turtle-dove, are in each case the smallest eggs examined within their respective orders or families. To this we may add that the two smallest eggs of Corvidæ (jay and magpie) were both recorded (in two observations out of six for each species) as bitter; the same being true of the puffin—the smallest of three auks examined.

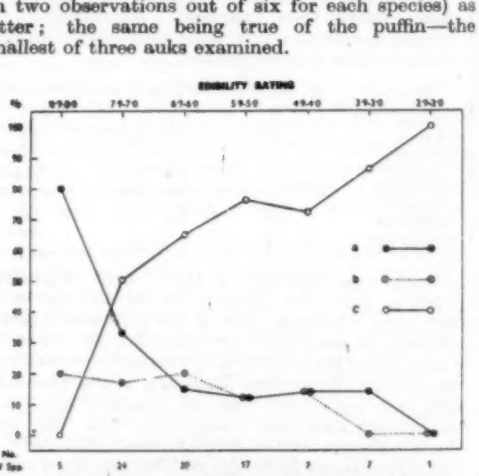

Fig. 2. PERCENTAGES, IN GRADED EDIBILITY GROUPS, OF SPECIES IN WHICH (*a*) THE EGGS ARE CRYPTIC, (*b*) NON-CRYPTIC EGGS ARE COVERED BY A CRYPTIC PARENT, (*c*) NEITHER EGGS NOR PARENTS ARE CRYPTIC

This incidence of bitterness among the smaller eggs laid by members of four different orders, Passeriformes, Charadriiformes, Gruiformes and Columbiformes, raises an interesting ecological question, and suggests that this quality may have been developed as a deterrent to attack by potential egg-eating predators. Obviously, the point requires further investigation, especially in the light of field observations, but the suggestion appears to be supported by three types of evidence.

In the first place, while distasteful properties of the egg appear to be neither directly related to the feeding-habits nor to the palatability of the parent bird, they are, on the other hand, often associated with small size and with conspicuousness. Size is an important factor in the vulnerability of a species in Nature. In the absence of compensating adaptations, smaller birds are liable to attack by a wider range of predators, and are less able to protect themselves and their eggs during the incubation period than larger species. Consequently any deterrent property such as relative distastefulness in the eggs of such birds is likely to be of selective value in the interspecific struggle for existence—especially if it is associated with conspicuous coloration easily recognized and remembered by potential predators.

Secondly, Rensch[6] has shown, in his work on the sensitivity of birds to various tastes, that the lower limit of (externally ascertainable) taste perception is not markedly different from that of man; and that while relative insensitivity to bitterness is characteristic of birds feeding on seeds or insects which often have a sharp or bitter flavour, other species, and in particular birds of prey, such as the goshawk (*Accipiter gentilis*) and tawny owl (*Strix aluco*), are especially sensitive to bitterness.

A third approach to the question is through feeding experiments with egg-eating predators. We have already noted that there is a fair agreement between the palatability ratings of man and the apparent preferences of the ferret, rat, hedgehog and mongoose, and that this agreement is closest for the eggs rated as least edible by man. The series of thirty-five egg-species used in the rat tests includes eleven species rated as bitter, and all these occur in the lower half of the palatability sequence. Among eighteen species used in the hedgehog experiments, the three which appear at the end of the list as least palatable to these animals are the only three markedly bitter eggs offered.

In conclusion, it may be noted that previous work on the relative edibility of the flesh of birds affords a series of facts parallel in many respects to those here considered. Thus cryptic coloration, whether of plumage or egg-shell, appears to be correlated with palatability; and conspicuousness, in otherwise vulnerable species, often to be associated with a distasteful or deterrent property. I hope to continue the present investigation next season, and should be glad to hear from anyone (*a*) who has tasted eggs of tropical or other species not usually eaten by man, or (*b*) who might be willing to submit newly laid eggs (of species not included in the above series) for examination.

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[2] Cott, H. B., *Proc. Zool. Soc. London*, **116**, 371 (1946).
[3] Swynnerton, C. F. M., *Ibis*, (10), **4**, 529 (1916).
[4] Davies, G., Report of the Food Investigation Board for the Year 1936, 51 (1936).
[5] Murphy, R. C., "Oceanic Birds of South America" (New York, 1936).
[6] Rensch, B., *J. Ornith.*, **73**, 633 (1925).

SCIENTIFIC CENTENARIES IN 1948

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE past year has seen the commemoration of the centenaries of many men and institutions, and thus homage has been paid, memories recalled, interest aroused and history enriched. Notable among commemorations in the realm of science and technology were those associated with the Chemical Society, the Institution of Mechanical Engineers, the Royal Netherlands Institution of Engineers, King's College Engineering Society, and with Edison, Graham Bell and Denis Papin. Papin's work (see *Nature*, Sept. 27, 1947, p. 422) belonged mainly to the seventeenth century, which saw the foundation of the Royal Society in 1660 and of the Paris Academy of Sciences in 1666. Both these bodies sprang from earlier meetings of men with scientific leanings, and the meetings in France are recalled by the tercentenary of the death of Marin Mersenne, who carried on a large correspondence with men of science and joined with Mydorge, Roberval, Pascal and others in friendly discussions. Born at Souitière (Sarthe) on September 8, 1588, he was educated at La Flèche, where for a time Descartes was his school-fellow, studied at the Sorbonne and entered the priesthood. He became the superior of a convent of his order in Paris, and he died there on September 1, 1648. An amiable and conciliatory man, he was given to experimenting, translated Galileo's mechanics, contributed to mathematics and was much devoted to music.

Turning back to the later part of the Renaissance, the year 1548 saw the birth of Simon Stevin, the Dutch mathematician, a friend of Prince Maurice of Orange, by whom he was made quartermaster-general of the Dutch Army. His best work was done in fortification and military engineering; but he is remembered for his invention of decimal fractions and as one of the first to revive the study of statics. Cajori wrote of him as "a man remarkable for attainments in science, independence of thought and extreme lack of respect for authority". His statue was erected at Bruges in 1847.

It was such men as Stevin and Mersenne, whose lives overlapped those of Kepler, Galileo and Newton, who helped to pave the way for the great discoveries and advances made in the eighteenth century, so rich in the names of famous men, of whom the first to be mentioned is John Bernoulli, who died at Basle on January 1, 1748. No fewer than eight members of the Bernoulli family achieved fame as mathematicians, John being the eldest. His equally distinguished brother James died in 1705 at the early age of fifty, but John lived to be eighty years of age, leaving two sons, Daniel and John, and a grandson, another John, to maintain the family traditions. Especially remembered for his work on the calculus, John the first had a temperament in marked contrast to that of the priestly Mersenne; but, said Ball, "he was, however, the most successful teacher of his age and had the faculty of inspiring his pupils with almost as passionate a zeal for mathematics as he felt himself". Born at Basle on August 7, 1667, from 1695 to 1705 he held a chair of mathematics at Groningen and then returned home to fill the chair left vacant by his brother's death. For twenty years he corresponded with Leibniz. He was a foreign associate for forty years of the Paris Academy of Sciences, and D'Alembert declared that whatever he

knew of mathematics he owed to the works of this great mathematician.

Bernoulli's fame was earned by work steadily pursued over half a century; the name of his contemporary, the German physicist and ecclesiastic, Ewald Georg von Kleist (1700–48), is remembered for a single electrical experiment made in 1745 with a phial, a nail and an electrical machine. Much the same experiment was made a year later by Musschenbroek at Leyden, giving rise to the so-called Leyden jar, a piece of apparatus which became popular with itinerant showmen. Kleist, who was dean of the cathedral at Cammin, in Pomerania, made his experiment in his house, and a tablet thereon, erected in 1898, recalls the episode.

If John Bernoulli be regarded as the outstanding man of science who died in 1748, the most eminent born that year was undoubtedly the French chemist Claude-Louis, Comte Berthollet, one of that distinguished group who made Paris the scientific centre of the world in the days of Napoleon. Though born at Talloires near Annecy, in the Savoy, then an Italian possession, and educated partly at Turin, Berthollet passed the greater part of his life in the French capital, near which he died in 1822. As the discoverer of the composition of ammonia, the supporter of the views of Lavoisier, the director of the Government dye-works, a reorganiser of the Academies and the companion of Napoleon, he enjoyed a great reputation. Sir David Brewster, who was in Paris in 1814, related how he was taken by Laplace, Biot and Poisson to see Berthollet at his house at Arceuil, and how Berthollet and his wife met them: "A more homely pair you never saw, and though very rich, they were dressed little better than a decent Scotch farmer and his wife". It was at Berthollet's house that the English chemist and experimentalist Sir Charles Blagden (1748–1820) died suddenly. An army surgeon, Blagden was a legatee of Cavendish, a friend of Sir Joseph Banks, and during 1784–97 was secretary of the Royal Society. Before his election, there had been dissensions among the fellows of the Society, but on his assumption of office, records Weld, "The ordinary meetings resumed their former scientific appearances, and if harmony was not entirely restored, at least there was no longer any violent attempts to interrupt the regular business of the Society".

Two other distinguished French men of science were born in the same year as Berthollet, one being the botanist Antoine-Laurent Jussieu (1748–1836), long connected with the Jardin des Plantes, the other Jacques-Dominique Comte de Cassini (1748-1845), the last of the four Cassinis who directed the Paris Observatory. The Bernoullis, the Jussieus, and the Cassinis are all examples of science appealing to several members of the same family, and another such family is recalled by Johann Friedrich Gmelin (1748–1804), who held chairs at Tübingen and Göttingen. He and his relations were known as physicians, chemists and botanists. The year 1748 also saw the birth of Scipione Breislak (died 1826), an Italian geologist and a friend of Cuvier, of Pierre Louis Guinaud (died 1824), the watchmaker of Les Brenets near Le Locle in the Swiss Jura, who made important advances in the manufacture of optical glass, and of John Playfair (died 1819) of Edinburgh. It is perhaps difficult now to realize the great admiration and esteem felt in Scotland for Playfair. One of the most cultivated men of his time, he started his career as a minister, successively held the chairs of mathematics and natural philosophy in the University of Edinburgh, was a founder of the Royal Society of Edinburgh, and the centre of an interesting circle of literary and scientific men. Among his greatest friends was James Hutton. Five years after Hutton's death in 1797, Playfair published the classic "Illustrations of the Huttonian Theory of the Earth", a book Geikie advised every young student of geology to read (see *Nature*, Nov. 22, 1947, p. 694). "How different," wrote Geikie in 1897, "would geological literature be to-day if men had tried to think and write like Playfair." Finally, mention must be made of the tragic figure, Phillippe-Frédéric, Baron de Dietrich (1748–93), who like Lavoisier, Bailly and Bochart de Saron fell beneath the guillotine. A mineralogist of note, a member of the Academy of Sciences, a royal commissioner of mines and a magistrate of Strasbourg, during the Revolution he fled to Switzerland, but returning to France voluntarily he was tried once and acquitted, only to be condemned by the revolutionary tribunal. He was executed on December 28, 1793. By one account, it was at Dietrich's house at Strasbourg that Rouget de Lisle composed the "Marseillaise".

Moving forward another hundred years to the middle of last century, as might be expected inventors and engineers take their places besides the devotees of science, and no one will question the greatness of George Stephenson, universally honoured as the 'father of railways', who died at his home, Tapton House, near Chesterfield, on August 12, 1848, at the age of sixty-seven. Of scarcely less stature was Jons Jakob, Baron Berzelius, the Swedish chemist, who passed away at Stockholm five days earlier, at the age of sixty-eight. In the gardens at Stockholm "not far from the statues of kings, amidst trees, with a fountain playing before it, is the bronze figure of Berzelius, the great chemist. He is enveloped in a thick heavy mantel, the stoic fur of the philosopher, and the face and the whole pose indicate the union of perseverance and intelligence which belong to such conquerors in the field of science." Sir William Ramsay once said of Berzelius that "he believed that since the time of Boyle none had done more for the advancement of chemistry". To the same period belong the labours of the German engineer Johann Albert Eytelwein (1764–1848), and the French engineer Baptiste-Alexis Legrand (1791-1848), for sixteen years head of the Corps des Ponts et Chaussées, and also the Alsatian mechanician Joshua Heilmann (1796–1848), who secured for himself a place among the improvers of textile machinery. On January 8, 1848, Caroline Herschel, long the assistant of her brother Sir William Herschel, died in Hanover when nearly ninety-eight. Twenty years before, the Royal Astronomical Society had awarded her its Gold Medal, and seven years before her death had placed her name among its honorary members, the first woman to be so honoured. Another astronomer who worked in the early part of the nineteenth century was the Jesuit father, Francesco de Vico (1805–48), who six times won the gold medal offered by the King of Denmark for the discovery of telescopic comets. De Vico's work was done in Rome; but the political disturbances of 1848 led him to join Georgetown College in the United States. Travelling to England on business, he contracted typhus and died in London on November 15, 1848. To these names may be added those of Sir George Steuart Mackenzie (1780–1848), who discovered the identity of diamonds and carbon; Wilhelm Albrecht (1786–

1848), who introduced scientific methods into agriculture in western Germany and directed the Normal Agricultural Institute at Geisberg; George Augustus Goldfuss (1782–1848), professor of zoology and mineralogy at Bonn; Josiah Christopher Gamble (1776–1848), one of the founders of the British chemical industry, and Sir John Barrow (1764–1848), who from being a timekeeper in a Liverpool iron foundry rose to be the Secretary of the Admiralty and became the virtual founder of the Royal Geographical Society. The cottage at Ulverston in which Barrow was born now bears a memorial tablet, while on the summit on the hill behind is the tower erected in his memory.

In an age which has seen the spread of education, the founding of many colleges, universities, laboratories and scientific societies, a remarkable increase in inventions and the harnessing of science to industry, the centenaries of men of science born a century ago, who as investigators, teachers, writers or administrators have left their mark, fall fast and thick. Each year, indeed, brings a longer and longer list. Taken in chronological order, the year 1848 saw the birth in February of Josiah Richard Perrett (died 1918), who from a dockyard apprentice rose to be the chief naval architect at Elswick, where he built many fine warships. In March occurred the birth of Shelford Bidwell (died 1909), known for his work in electricity and magnetism, who served as president of the Physical Society during 1897–99; of the Austrian scientist Josef Maria Pernter (died 1908), for many years a leader of meteorology in his country; of the German pioneer of flight, Otto Lilienthal, who was accidentally killed while gliding in 1896, and whose monument is to be seen at East Lichterfelde, Berlin; and of Henry Marion Howe (died 1922), the leading American metallurgist of his day.

The Rev. Frederick John Jervis-Smith (died 1911), of Trinity College, Oxford, who represented his University at the tercentenary of Torricelli at Faenza in 1908, was born in April 1848; and Vero Charles Driffield (died 1915), the eminent manufacturing chemist and collaborator with Hurter, was also born in the same month. In July of that year the physicist Baron Roland von Eötvös (died 1919) was born at Budapest. A pupil of Helmholtz, Kirchhoff and Bunsen, he founded the Hungarian Mathematical and Physical Society and for many years was president of the Hungarian Academy of Science. In the following month Paul Henri (died 1905), brother of Matthieu-Prosper Henri (1849–1903), was born at Nancy. Their outstanding work at the Paris Observatory gained for them both the associateship of the Royal Astronomical Society. Seldom, if ever, have two brothers been such close collaborators. The famous German chemist, Victor Meyer (died 1897), was born in Berlin on September 8, 1848, and became Bunsen's successor at Heidelberg, where Sir Edward Thorpe first knew him. Thirty years later, Thorpe delivered the memorial lecture on Meyer to the Chemical Society, giving a fascinating picture of one whom he first remembered as a "bright-eyed youth, quick of movement and action, ready and fluent of speech and full of zeal". In many of his characteristics, Meyer, said Thorpe, was not unlike Davy.

The list of physicists born in 1848 includes also Sir Arthur Rücker (died 1915), Henry Augustus Rowland (died 1901), and Sigmund von Wroblewski (died 1888). Rücker was born on October 23 and Rowland on November 27. A Royal Medallist and secretary of the Royal Society, Rücker was professor of physics for fifteen years at the Royal College of Science, London, and then principal of the University of London. Rowland held the chair of physics in the Johns Hopkins University, Baltimore, from its foundation in 1876, a post for which he was recommended by Maxwell. Wroblewski, like many of his compatriots, suffered for taking part in the Polish insurrection in 1863, and spent six years in exile in Siberia. Afterwards he was able to work under Helmholtz; in 1874 he went from Berlin to Strasbourg, and in 1882 became professor of experimental physics in the University of Cracow; where, working with Karl Olszewski, he liquefied in considerable quantities the three gases oxygen, nitrogen and hydrogen. He met his death on April 16, 1888, at the early age of forty, through the accidental overturning of a lamp.

Finally, it may be recalled that on May 12, 1748, Thomas Lowndes died at the age of fifty-five, leaving his property in Cheshire to found a chair of astronomy at Cambridge, the first occupant of which was Dr. Roger Long (1680–1770), vice-chancellor of the University from 1733 until 1769. The reason for Lowndes' bequest is obscure, for his activities had been concerned with the colonization of South Carolina, the manufacture of potash, the decay of England's wool industry and the supply of salt to the Navy.

OBITUARIES

Prof. Max Planck, For.Mem.R.S.

Prof. Max Planck died on October 4 in Göttingen at the age of eighty-nine. The burial service was held in the crowded church of St. Alban, where addresses of appreciation were given by the officiating minister and by Profs. O. Hahn and M. von Laue. It is hoped to hold a larger memorial service in the spring of next year, probably on the ninetieth anniversary of Planck's birthday.

Planck was born in Kiel on April 23, 1858. His father was professor of constitutional law in the University of Kiel and later in Göttingen. He took the degree of doctor of philosophy at Munich at the age of twenty-two, the subject of his thesis being the second law of the mechanical theory of heat. In 1885 he was appointed professor *extraordinarius* in Kiel. His association with the University of Berlin began in 1889 and lasted for fifty years: he was appointed professor *ordinarius* in 1892. In 1920 he was awarded the Nobel Prize for Physics and in 1926 was elected a foreign member of the Royal Society. He was granted the title of professor emeritus in 1926; but this was not to usher him to a period of retirement, for shortly afterwards he became president of the Kaiser Wilhelm Institute for the Promotion of Science, an appointment which he held until 1937. Planck's original and critical writings extended from about 1879 until shortly before his death. He was, indeed, engaged in writing down some of his latest views during his visit to Great Britain last year.

In his early twenties, Planck attended lectures given by Kirchhoff in Berlin. He had a great admiration for Kirchhoff's work, and it may be supposed that this was one of the influences which directed him to the study of thermodynamics and the theory of radiant heat.

A very early paper, written at the age of twenty-two, was on the theory of the law of saturation. The statement of this law he expresses in the form: in the case of each isothermal the straight line, parallel to the axis of abscissæ, which represents the pressure of the saturated vapour, lies so that the areas between it and the isothermal are equal. This work appeared almost simultaneously with a paper by Clausius, who reached the same conclusion.

There is a feature of this early paper which is characteristic of his outlook. He was always ready to apply himself to concrete examples and to put his conclusions to the test of experiment. In this case he calculated the pressure of saturated carbon dioxide and made a comparison with the results of Andrews' experiments.

During the following decade, he published a number of papers on thermo-electricity and on the theory of dilute solutions. Between 1890 and 1900 he appears to have concentrated particularly upon thermodynamics and the process of radiation. The first edition of his treatise on thermodynamics appeared in 1897, and this work alone places him in the front rank as a clear and critical thinker. It is perhaps the greatest work on this subject, and it is certainly a classic. At the same time he was writing upon the processes of radiation. He showed that these were to be considered as electromagnetic, the phenomena being confined to the oscillation of certain entities analogous to Hertzian oscillators connected in some way with the atoms of matter. The phenomenon of absorption of radiant heat was not to be regarded as a consequence of ohmic resistance or friction of any kind, but simply as a phenomenon of resonance; the oscillators were regarded not merely as emitters of waves, but also as capable of excitation by incident waves.

These studies of thermodynamics and of electromagnetic vibrations brought Planck naturally to the problem of the distribution of energy in the spectrum of full radiation. His famous formula was first given in the latter half of the year 1900. He had come to the conclusion that the law of energy distribution could be completely solved if the entropy of an irradiated monochromatic resonator could be expressed as a function of its energy U. The essential part of his work was the discovery of this expression. In an earlier attempt he had deduced Wien's law and expected it to have general validity. This law fails as a general law on experimental grounds, so Planck found it necessary to consider more closely the concept of entropy.

By applying Boltzmann's equation from the theory of gases, relating entropy and probability, to a set of resonators the energy of which must necessarily occur in discrete multiples of an amount ε, he was able to show that the entropy was a function of U/ε. At the same time, by means of Wien's displacement law, he realized that, ν being the frequency of the radiation emitted, the entropy was a function of U/ν. He was thus led to his famous relation between the elements of energy and the frequency and to the introduction of the constant h, named universally after him.

This was the climax of Planck's work. It was also a climax in the history of physics, for there had been nothing of greater importance since the time of Newton. But in 1900 there was no suggestion of a climax. Planck's work continued and his contemporaries were unconvinced or sceptical. In the same volume in the *Annalen der Physik* as that in which Planck's work was published appears a paper by Rubens and Kurlbaum on the experimental proof of the law of radiation, in which it is stated that the two formulæ best fitted to express the law are those suggested by Lummer and Pringsheim and by Planck, though Planck's has the advantage of its greater simplicity.

It is also of interest to recall that Jeans' contributions to this question were made between 1900 and 1910, and in this latter year Planck, in a summary of the situation, describes this work of Jeans as faultless and as the most satisfactory from the point of view of the accepted theories of physics, but as a failure from the point of view of experiment. It may be that the unwillingness to accept Planck's theory at this time was partly due to his clear statement of the assumptions made. These may have caused his contemporaries to hope that they might ultimately be set aside, leaving the old doctrines sufficient.

When asked many years later what he had felt in this period, he replied: "I knew I could wait", and on another occasion: "I am glad I led no one astray". The gradual accumulation of data from the domain of atomic physics, from Einstein's theory of the photo-electric effect and from the work of Rutherford and Bohr, are familiar to all students of physics. But it took a quarter of a century of theoretical and experimental work to build up a self-contained quantum theory. This is the measure of the quality of Planck's insight and inspiration.

But he appears always to have hoped for the establishment of a theory harmonizing the classical and quantum points of view. This was evident in his interest, even his delight, in Schroedinger's theory of wave mechanics which, by the title of his first paper, "Quantization as a Problem of Characteristic Values", raised hopes which have not been realized.

On wave mechanics Planck published papers in 1940 and 1941. He does not appear to have followed modern developments beyond this stage.

Planck remained mentally clear and active to the end; but during the last two years he was physically weak and easily became tired during conversation and in his efforts at writing.

There is no doubt about Planck's place in science. His name will be remembered with those of Newton and Einstein for generations. For the shorter period of the lives of those who knew him, he will be remembered with a rare affection. Among his colleagues and, indeed, among his countrymen, he inspired a deep respect akin to reverence. This was due not merely to the importance and originality of his scientific discoveries, but also to his great personal qualities, to his sympathy, modesty and patience.

His friends and students will delight to recall his piano accompaniments with Einstein playing the violin. Even in Great Britain there are some who have enjoyed his gift as a pianist. He has said that at one time he considered music as a career.

He was twice married and suffered heavy blows in the loss of two sons and twin daughters. These sorrows saddened but did not embitter him, and he was always ready to give sympathy in matters which, compared to his own sufferings, must have seemed trivialities. His second wife and one son survive him. The end of the War had involved him in disaster. His house in Berlin was destroyed and his source of income vanished. In the last days of the War he was homeless and took shelter in a wood until he was recognized by members of the American Army. He

ultimately found shelter in very limited quarters in the house of his grand-niece in Göttingen.

Planck was unpopular with the former German Government on account of his refusal to be associated with the movement for 'German physics' and on account of his admiration for the work of Einstein. Moreover, he appealed personally at the highest level for a relaxation of the persecution of Jewish men of science. A very gifted son, a Secretary of State to an earlier German Government, was executed for alleged complicity in the plot to overthrow the Nazi regime in the last stage of the War.

These experiences had greatly enfeebled Planck, when he was invited by the Royal Society to take part in the Newton celebrations last year. In spite of the anxiety of his relatives he insisted on undertaking the journey in order, as he said, to reopen the bridge which united the physicists of both countries. His old friends were pained to see his enfeeblement, but they will all be glad to know that he returned home refreshed in mind and body by the renewal of old friendships and by the hospitality so readily offered. Of the latter aspect of his visit his own words were: "Ich lebe wie im Schlaraffenland".

One of the last letters he wrote was to friends in Britain on the anniversary of his visit, recalling happy memories of it. Before the letter could be posted he had a bad fall and sustained bruises and a slight fracture from which he did not recover.

H. T. FLINT

WE regret to announce the following deaths:

Prof. J. N. Brönsted, professor of chemistry in the University of Copenhagen, on December 17.

Prof. A. N. Whitehead, O.M., F.R.S., professor of philosophy in Harvard University during 1924–37, on December 30, aged eighty-six.

ERRATUM.—In *Nature* of December 13, p. 821, the death was announced of Mr. S. A. Courtauld. This was incorrect; the reference should have been to Mr. S. Courtauld, a trustee of the National Gallery, who died on December 1 at the age of seventy-one.

NEWS and VIEWS

Social Studies in Manchester: Appointment of Prof. M. Polanyi, F.R.S.

PROF. MICHAEL POLANYI has been appointed professor of social studies in the University of Manchester in lieu of his present position as professor of physical chemistry. The change of duties will become effective after Easter of this year. Prof. Polanyi graduated in medicine in the University of Budapest. Later he was appointed professor of chemistry in the Technical High School, Berlin, and taught in the Kaiser Wilhelm Institute, publishing much original work. In 1933 he accepted an invitation to become professor of physical chemistry in the University of Manchester, where he has conducted distinguished teaching and research, and has directed a stream of research workers in that subject. Prof. Polanyi's wide experience and range of interests have brought him closely into contact with investigators and teachers in social studies and in economics, and in recent years he has produced a number of papers on aspects of those subjects. These include volumes entitled "The Contempt of Freedom" and "Full Employment and Free Trade", together with a substantial number of essays in this field published in economic and other journals. In 1946 he accepted an invitation to deliver the Riddell Lectures in the University of Durham, his subject being "Science, Faith and Society". He has recently accepted an invitation to give the Gifford Lectures for 1949–50 in the University of Aberdeen.

University College, Exeter, and the Norman Lockyer Observatory

ARRANGEMENTS have now been completed by which the astronomical observatory on Salcombe Hill, Devon, will become "The Norman Lockyer Observatory of the University College of the South West of England, Exeter". The Observatory occupies a commanding site of about 44 acres above Sidmouth, at an altitude of 565 ft.; and since its foundation in 1912 it has been maintained through funds provided by a few generous donors as a non-profit making corporation with articles of association approved by the Board of Trade. By the will of Lady Lockyer, who died in September 1943, some additional land, with her house and also her residuary estate, were bequeathed to the Corporation. These gifts brought the capital funds of the Observatory up to about £33,000 in March 1947, with an income therefrom of nearly £1,400 a year. The whole property is now being incorporated in the University College of the South West, with the buildings, telescopes and other equipment for astronomical research, under a scheme adopted by the Councils of the College and of the Observatory Corporation. The director (Mr. D. L. Edwards) and chief assistant will thus become attached to the staff of the College, and the registrar of the College will become secretary of the Observatory Corporation. Under the revised articles of association, the future Council of the Observatory Corporation will consist of not more than twenty persons nominated by the Council of the College and not more than five nominated by the Corporation. By this provision, leading British astronomers will still be able to ensure the promotion of the educational and research sides of astronomy, in which, because of lack of financial support, Great Britain has lagged behind other countries in many of the new developments.

The work of the Norman Lockyer Observatory hitherto has mainly dealt with stellar spectroscopy; but the erection of the Mond astrographic instrument has enabled a somewhat wider field of astrophysical research to be included. In all, sixty-one papers from the Observatory have been accepted by the Royal Astronomical Society, in addition to a number of contributions published elsewhere. At present the principal routine programmes of work deal with colour temperatures of stars, bright-line stars, spectrum variables and galactic clusters. Work on the last is at the moment in abeyance, owing to shortage of staff, and progress in the other programmes is retarded for the same reason. Minor programmes are also kept in reserve for use when conditions are not suitable for the main routine work.

Jubilee of the Discovery of the Electron

In *Nature* of December 6, p. 776, an account was given of celebrations in London arranged by the Institute of Physics, the Physical Society, and the Institution of Electrical Engineers to mark the jubilee of the discovery of the electron by Sir J. J. Thomson in 1897. It is of interest to learn that the event was also remembered on the Continent. The Bernische Naturforschende Gesellschaft held a commemorative meeting in June 1947, with Dr. A. Kurz in the chair. An address was delivered by Prof. André Mercier; as a professor of theoretical physics, he insisted especially on the great influence that the discovery of the electron has had since 1897 on physical theories, particularly under the impulse given by H. A. Lorentz, W. Pauli and P. A. M. Dirac.

Institute of Metals: Elections

The Council of the Institute of Metals has made the following elections: *Fellows* (members who have rendered eminent service to the Institute), Dr. C. H. Desch, formerly superintendent of the Metallurgy Division, National Physical Laboratory; Sir John Greenly, chairman of the British Non-Ferrous Metals Research Association and a past-president of the Institute of Metals. *Honorary Members* (in recognition of their distinguished services to the science or practice of non-ferrous metallurgy), Prof. P. A. J. Chevenard, member of the Institut de France, known for his work on special steels; Sir Geoffrey Taylor, Yarrow research professor of the Royal Society; Dr. J. F. Thompson, executive vice-president of the International Nickel Company of Canada, Ltd., known for his studies of the science and practice of non-ferrous metallurgy.

Ministries of Food and Health: Lasker Group Award

A Lasker Group Award for 1947 has been presented by the American Public Health Association to the British Ministries of Food and Health "for the unprecedented programme of food distribution in Great Britain" during the War, "with resulting improvement in the health of the people". The Lasker Award, which takes the form of a statuette of the "Winged Victory of Samothrace", was provided through the generosity of the Albert and Mary Lasker Foundation, and is made either to individuals for their achievement in the field of medical research and public health administration or to groups for outstanding work or research. This is the first occasion on which the award has been given outside the United States.

Nuffield (Penicillin) Research Fellowships

Lord Nuffield has given £50,000 to Lincoln College, Oxford, of which Sir Howard Florey is a fellow, to establish three research fellowships in science and allied medicine. The gift is to commemorate the discovery, in the Sir William Dunn School of Pathology, of which Sir Howard Florey is head, of the chemotherapeutic properties of penicillin. The fellowships are to be known as Nuffield (Penicillin) Research Fellowships.

University of Glasgow

The following appointments in the University of Glasgow have been announced: Prof. Thomas Alty, Cargill professor of natural philosophy, deputy principal; Dr. Basil C. King, lecturer in geology; Messrs. Daniel Martin and Walter Brown, lecturers in mathematics; Messrs. John B. Birks (formerly an I.C.I. Fellow) and G. M. Lewis (from University College, Hull), lecturers in natural philosophy; and (from April 1, 1948) Dr. William C. Hutchison, lecturer in physiology in the University of Edinburgh, and Mr. George Leaf (from the National Institute for Medical Research), lecturers in physiological chemistry.

For the 1947–48 session, 350 students have been admitted to the various first-year classes covered by the Faculty of Science—280 in pure science and 70 in applied. These numbers represent a slight reduction compared with the 1946–47 session. Of the 250 fresh admissions, about 45 per cent are ex-Servicemen. Of the graduate research students who have been registered, or re-registered, about sixty are at the University and forty at the Royal Technical College, Glasgow.

University of Leeds: Appointments

The following appointments in the University of Leeds have been announced: Dr. W. Bradley (at present research director at the British Drug Houses, Ltd.), professor of colour chemistry and dyeing, in succession to the late Prof. F. M. Rowe; Mr. A. H. Hanson, lecturer in the Departments of Social Studies and Extra-Mural Studies; Mr. H. D. Ursell, lecturer in mathematics, to succeed Mr. R. M. Gabriel as reader in mathematical analysis.

University of Sheffield: Appointments

The following appointments in the University of Sheffield have been announced: Dr. S. R. Elsden, senior lecturer in microbiology in the Department of Bacteriology; R. O'Rahilly, lecturer in anatomy; T. F. Bamber (at present research assistant), assistant lecturer in the Department of Mining; Dr. J. L. Emery, honorary lecturer in pathology.

Agricultural Research Council: Postgraduate Scholarships

The Agricultural Research Council announces the following awards of postgraduate scholarships in agricultural science and in animal health, to be held at the university or college mentioned from the beginning of the academic year 1947: P. Aitkenhead (Durham), a two-year research scholarship in entomology; N. Bateman (London), a three-year research scholarship in animal genetics; J. R. Butler (Cambridge), a three-year research scholarship in soil mineralogy; J. W. B. King (Cambridge), a three-year research scholarship in animal genetics; D. Lewis (Wales), a three-year scholarship in biochemistry; A. M. McCallum (Glasgow Veterinary College), a one-year research scholarship in animal health; I. A. Nicholson (Durham), a three-year research scholarship in plant breeding; H. Platt (Liverpool), a one-year research scholarship in animal pathology; Miss P. E. Stokes (London), a three-year research scholarship in plant physiology; K. F. Thompson (Cambridge), a three-year research scholarship in plant genetics; G. M. Urquhart (Glasgow Veterinary College), a one-year research scholarship in animal parasitology; D. P. Webley (Durham), a one-year research scholarship in entomology; Miss J. N. Winfield (Leeds), research scholarship in plant pathology renewed for one further year from October 1, 1947.

Type Cultures of Fungi

From January 1, the National Collection of Type Cultures preserved by the Lister Institute has

ceased to maintain and distribute cultures of fungi and yeasts; it is now confining its activities to bacteria and viruses. Most of the fungi, except yeasts and fungi of medical interest, from the National Collection of Type Cultures, have been transferred to the Imperial Mycological Institute, which proposes to maintain cultures of phytopathogenic, taxonomic and economic interest, provided expected financial support is forthcoming. Applications for cultures should be addressed to the Director of the Institute at Ferry Lane, Kew, Surrey. Timber-rotting fungi can be obtained, as before, from the Director, Forest Products Research Laboratory, Princes Risborough, Bucks.

Conference on Films in Agriculture

THE Scientific Film Association is organising a one-day conference to be held on January 17 at the Caxton Hall, London, at which the present state and the future development of the use of films in agriculture and their place in the drive for increasing production will be discussed. The chair will be taken by Prof. J. A. Scott Watson, chief scientific and agricultural adviser to the Ministry of Agriculture and Fisheries. Mr. G. Goodman (Ministry of Agriculture) will speak on the scope, and Mr. A. Vesselo (Central Film Library) on the sources and distribution of agricultural films. Dr. W. K. Slater (senior education and advisory officer of the Ministry of Agriculture) will discuss the use of the instructional film in agriculture; Mr. R. Kenney, lecturer in agriculture, University of Reading, will deal with its use in university training and research; and Mr. E. Anstey (Film Centre) with the making of agricultural teaching films. In the evening a show of selected British and foreign agricultural films will be given. Further information and tickets (£1 1*s*. each, including buffet lunch and tea) can be obtained from the Conference Secretary, Scientific Film Association, 34 Soho Square, London, W.1.

Geographical Distribution of Deaths from Cancer

THE General Register Office has initiated a series of occasional publications under the title of "Studies on Medical and Population Subjects". The purpose of the series is to present a more detailed treatment of certain important subjects than is possible in the Registrar General's Annual Statistical Review. The first publication is by Dr. Percy Stocks, and studies geographical variations in mortality from cancer of various sites (Regional and Local Differences in Cancer Death Rates. London: H.M. Stationery Office. 1*s*. net). One of the underlying difficulties in such a study is the uncertainty as to the accuracy of the certified cause of death, particularly in relation to inaccessible sites. It is, however, impossible to dismiss all the local differences demonstrated by Dr. Stocks as due to such variations in certification practice, and this study investigates other possible explanations. Correlations with social indices show a marked relationship with stomach cancer, but none with lung cancer. However, lung cancer mortality is closely associated with annual hours of sunshine in twenty large towns, and this suggests that a beneficial effect of sunshine or a deleterious effect of smoke may operate. A grouping of London boroughs according to their water supply is reminiscent of Farr and cholera, but is not so revealing. Dr. Stocks has brought together a great deal of information and has put forward many suggestions for more intensive research.

Comet 1947*n*

THIS comet was discovered in the southern hemisphere on December 8, and was described as diffuse with stellar condensation and a tail longer than 1°. Its magnitude was − 5, and it was moving northward. Dr. Cunningham computed an orbit from observations supplied; but as these may not have been very accurate, the orbit must be regarded as merely provisional. The elements of the orbit and an ephemeris are given below:

T	1947 December 2·710 U.T.	
Ω	341° 05′	1947·0
ω	197 00	
i	133 54	
q	0·0999	

1948	α	δ	r	ρ
Jan. 2·0	21h. 30·5m.	− 24° 18′	0·979	1·552
6·0	21 43·2	22 36	1·069	1·680
10·0	21 54·0	21 05	1·155	1·805
14·0	22 03·5	19 44	1·241	1·928

The Night Sky in January

NEW moon occurs on Jan. 11d. 07h. 44m., U.T., and full moon on Jan. 26d. 07h. 11m. The following conjunctions with the moon take place: Jan. 8d. 14h., Jupiter 3° N.; Jan. 14d. 04h., Venus 4° N.; Jan. 27d. 05h., Saturn 4° S.; Jan. 28d. 06h., Mars 0·6° S. Mercury, in superior conjunction on Jan. 3, becomes an evening star later and sets at 16h. 52m., and 18h. 15m., at the middle and end of the month, respectively, but the planet lies too low for good visibility. Venus, an evening star of stellar magnitude −3·4, sets at 18h. 23m., 19h. 08m. and 20h., at the beginning, middle and end of the month, respectively, and is a conspicuous object, about 80 per cent of the illuminated disk being visible. Mars, in the constellation of Leo, is visible throughout the greater portion of the night, rising at 21h., 20h. 04m. and 18h. 41m., on Jan. 1, 15 and 31, respectively. Jupiter is not visible until the late morning hours, its time of rising on Jan. 1 being 6h. 20m., and 4h. 50m. on Jan. 31. As the planet does not attain an altitude of 17° in the latitude of Greenwich, it is not very suitably placed for observation. Saturn, in the constellation of Leo, is visible throughout most of the night, rising at 19h. 46m. and 17h. 30m., at the beginning and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: Jan 3d. 05h. 35·1m., γ Virg. m. (*D*); Jan. 3d. 06h. 48·5m., γ Virg. (*R*); Jan. 17d. 19h. 45·7m., 14 Ceti (*D*); Jan. 23d. 20h. 51·9m., 139 Taur. (*D*). *D* and *R* refer to disappearance and reappearance, respectively, and the latitude and longitude of Greenwich are assumed. In addition to these occultations of stars, Mars is occulted on Jan. 28d. 06h. 09·9m., reappearing at 6h. 26·3m. The earth is in perihelion on Jan. 2.

Announcements

VISCOUNT FALMOUTH has been elected by the governors of the Imperial College of Science and Technology to be their chairman in succession to Lord Rayleigh, whose period of office terminated on May 31, 1947.

THE Council of the British Welding Research Association has accepted an offer from Messrs. British Oxygen Company, Ltd., to provide a prize fund of £100 a year for three years. A single prize of £100 is offered in 1948 for the best paper on a research into welding or its application. Papers must be submitted on or before September 30, 1948.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Acetylcholine and Body Temperature

Glaubach and Pick[1] were the first to find that procaine causes a fall of body temperature. The fall has recently been shown by Peczenik[2] to be greatly increased after adrenalectomy. The work of Dawes[3] in this laboratory on quinidine substitutes led him to point out that quinine, quinidine and procaine antagonize the effect of acetylcholine on many types of tissue. They reduce its effect on the heart and on the intestine, and they reduce its effect on skeletal muscle also (Harvey[4]). Thus procaine, in addition to being a local anæsthetic, reduces the action of acetylcholine in all forms of muscle. Recently, de Elio[5] has shown in this laboratory that procaine shares these properties, not only with quinidine, but also with atropine and with the analgesic 'Pethidine' (demerol), while Dews and Graham[6] have shown that the antihistamine substance 'Neoantergan' shares them too.

We have now tested atropine, benadryl, 'Pethidine' and quinidine to see if they affect the body temperature of mice as does procaine. We have discovered that they do, and that the fall they produce is augmented by adrenalectomy. Since the common property of these substances is that they depress the action of acetylcholine, it becomes probable that the maintenance of body temperature depends on a mechanism in which acetylcholine plays a part, and that the adrenal glands support such a mechanism against the depressant action of substances like procaine.

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N. K. Dutta

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University, Oxford.
Nov. 19.

[1] Glaubach, S., and Pick, E. P., *Arch. Exp. Path. Pharmak.*, **162**, 551 (1931).
[2] Peczenik, O., *Proc. Roy. Soc.*, B, **134**, 218 (1947).
[3] Dawes, G. S., *Brit. J. Pharmacol.*, **1**, 90 (1946).
[4] Harvey, A. M., *J. Physiol.*, **95**, 45 (1939).
[5] de Elio, F. J., *Brit. J. Pharmacol.* (in the press).
[6] Dews, P. B., and Graham, J. D. P., *Brit. J. Pharmacol.*, **1**, 278 (1946).

Cholinesterase Activity in Cerebro-Spinal Fluid

The published finding of Stedman and Stedman[1], that cholinesterase cannot be detected in cerebro-spinal fluid, appears to be generally accepted, for recent literature contains no account of further investigations in cholinesterase activity.

We have found that the cholinesterase activity of the cerebro-spinal fluid of forty-two human subjects was in each case considerably above the range of the spontaneous hydrolysis of the cholinesters.

The cholinesterase activity was determined manometrically by Warburg's method at 37·5° C., and the result expressed in cubic millimetres of carbon dioxide produced by 1 ml. cerebro-spinal fluid in a period of thirty minutes. 1·6–2 ml. cerebro-spinal fluid, with 0·2 ml. 2 per cent bicarbonate, were put in the main vessel of the ordinary conical containers, and in the side arm 0·2 ml. of the substrate solutions, which consisted of 0·3 *M* acetylcholine, or 0·3 *M* acetylmethylcholine ('Mecholyl'), or 0·06 *M* benzoylcholine, respectively. This procedure was adopted in the light of the recent investigations of Mendel and Rudney and Mendel and Mundell[2].

The cerebro-spinal fluid was obtained from psychotic patients suffering from organic (general paralysis of the insane) and non-organic (mania, schizophrenia) psychoses. The cholinesterase activity of individual specimens varied considerably: substrate acetylcholine, between 6·6 and 28·4; substrate acetylmethylcholine, between 5·4 and 23·6; substrate benzoylcholine, between 2·3 and 6·2.

The relation between cholinesterase activity of cerebro-spinal fluid and blood serum was: with acetylcholine as substrate, 1/90–1/150; with 'Mecholyl' as substrate, 1/8–1/40; with benzoylcholine as substrate, 1/125–1/300.

Specimens of cerebro-spinal fluid from a number of patients were mixed; the cholinesterase activity, using the different substrates, is shown in the accompanying table.

For preparatory reasons, we tried to absorb the cholinesterase by different absorbents: 'Permutit' ('Decalso'), kieselguhr and alumina. The result was negative; no activity was lost by treatment with any of the substances (see table).

	Hydrolysis (mm.³ CO_2 evolved by 1 ml. cerebro-spinal fluid in 30 min.) of			Nitrogen content (mgm./ml.)
	Acetylcholine 0·03 *M*	Acetylmethylcholine 0·03 *M*	Benzoylcholine 0·006 *M*	
Cerebro-spinal fluid mixture (16 patients)	23·6	12·4	4·6	1·18
After treatment with kieselguhr	25·1	11·8	5·2	1·19
After treatment with alumina	22·8	10·3	4·9	1·13
Cerebro-spinal fluid mixture (29 patients)	21·4	10·4	4·3	
After filtering through 'Decalso' column	21·5	9·6	4·6	
After boiling for four minutes	13·7	6·7	2·5	

It seems reasonable to suppose that the so-called true cholinesterase of Mendel and Rudney is the predominant enzyme system present in cerebro-spinal fluid.

We are now investigating possible relationships between the level of cerebro-spinal fluid cholinesterase and various disturbances of brain and mental function.

M. Reiss
R. E. Hemphill

Biochemical and Endocrinological Research Department,
Bristol Mental Hospitals. Sept. 1.

[1] Stedman, E., and Stedman, E., *Biochem. J.*, **29**, 2107 (1935).
[2] Mendel, B., and Rudney, H., *Biochem. J.*, **37**, 59 (1943). Mendel, B., and Mundell, D. B., *Biochem. J.*, **37**, 64 (1943). Mendel, B., Mundell, D. B., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).

Relation of Intermediary Metabolites to the Lowering of the Potency of Pancreatic Insulin in the Animal System

It has long been felt by several workers that adiposity is connected with the onset of diabetes mellitus. It has previously been reported by us[1] that the intermediary fat metabolites such as β-hydroxy butyric acid, aceto-acetic acid and pyruvic acid, when injected into normal rabbits in the form of their sodium salts, give rise to the condition of hyperglycæmia characterized by decreased sugar

tolerance in those animals. It has also been observed by us[2] that these substances can reduce the potency of external insulin while allowed to combine with them both *in vitro* as well as *in vivo*.

In order to obtain confirmatory evidence on this point, these metabolites were injected into normal guinea pigs beginning with 100 mgm. each animal per day, which was increased by 15 mgm. per animal per week.

The animals were depancreatized at intervals (15–30 days), and the insulin content of their pancreases was assayed on rabbits according to the usual method of Marks[3].

During the first stage of the experiments (that is, up to 15–25 days) there was observed much higher potency of the pancreatic insulin isolated from the animals injected with those metabolites; the activity being about 50 per cent higher than that of normal animals. But this stage of hyperactivity was soon followed by the gradual reduction of potency as measured by the percentage reduction of blood sugar in normal rabbits; this was found to be as low as 50 per cent of the normal values after seventy days.

These observations show that accumulation of intermediary fat metabolites is responsible for either lowering insulin secretion, or for decreasing the insulin potency in the system, and that these keto-bodies can be held responsible for the onset in the long run of diabetes mellitus.

Though hyperglycæmia thus caused may not be directly associated with the pancreatic damage, still it may be considered that the strain on the insulin-producing mechanism resulting from early hypertrophy and increased insulin production might ultimately lead to atrophy of the pancreatic islet cells, with consequent decrease in the insulin production.

Further investigations in this connexion as well as on the histological picture of the pancreas of the experimental animals are in progress.

M. C. Nath
H. D. Brahmachari

Department of Biochemistry,
University, Nagpur. Sept. 6.

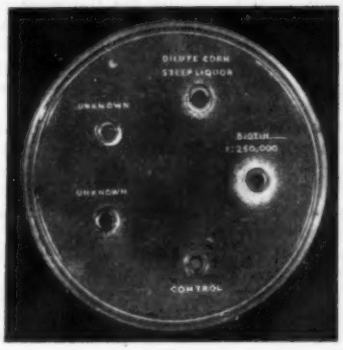
[1] Nath, M. C., and Brahmachari, H. D., *Nature*, **154**, 487 (1944).
[2] Nath, M. C., and Brahmachari, H. D., *Nature*, **157**, 336 (1946).
[3] Marks, C. H., *Quart. Bull. Health Organ. League of Nations, Geneva*, Spec. No. (Nov. 1936).

A Modified Microbiological Assay Procedure

Mr. A. L. Bacharach's letter[1] on the use of the plate-and-cylinder method in reverse for assaying certain growth-factors suggests that it may be of interest to record some very similar experiments which I carried out during 1944–45.

There was at that time a need for a simple and rapid method of approximately determining the biotin content of certain solutions. As the plate-and-cylinder method was then in daily use in the laboratory in connexion with research on antibiotics, the possibility of applying the method for assaying substances which promoted instead of inhibited growth was investigated.

Sterile agar containing glucose and mineral salts was poured into Petri dishes and the surface was seeded with the test organism, a strain of *Saccharomyces cerevisiæ*. The method of seeding was the same as that used for seeding plates with *S. aureus* for the assay of penicillin[2]. Cylinders for containing the liquids to be assayed were placed on the surface of the agar in the usual way.



The cylinders were filled with the solutions to be tested, using a 1 : 250,000 solution of pure biotin as a standard and saline as a control, and the plates were incubated at 37° C. Although growth proceeded slowly over the whole surface of the agar, it was very much more prolific around the cylinders containing the standard solution of biotin or other liquids in which biotin was known to be present. This effect is clearly shown in the accompanying photograph.

It was found that results were fairly reproducible and that it was possible to plot a graph relating ring-size to biotin concentration which gave consistent results over a considerable range when used to determine the strength of other solutions. Alternatively, solutions could be assayed by comparing them on the same plate with known dilutions of a standard biotin solution.

There seems to be no reason why this method of assay should not be generally applied and give results comparable with those obtained in the assay of antibacterial substances by the normal plate-and-cylinder method. Experience suggests that the main difficulties which may be encountered are as follows:

(1) Unless the micro-organism chosen is one the response of which to the various known growth-factors has been closely studied, there may be doubt as to whether the observed promotion of growth is, in fact, specifically due to the growth-factor under investigation. Certain derivatives of biotin, for example, possess the same kind of physiological activity as biotin itself. This danger is, of course, most serious when highly complex substances of largely unknown composition are being assayed.

(2) The edges of the 'rings of exhibition' are not always sharply defined. Among the factors which, by experience and by analogy with the assay of antibacterial substances, would be expected to influence this are the nature of the test organism, the thickness with which the agar is seeded, and the concentration of the substance being assayed.

(3) It may sometimes be difficult to prepare a culture medium which requires only the addition of a single growth-promoting substance to determine whether growth is negligible or prolific.

This work was done while I was a Nuffield Research Student at the Sir William Dunn School of Pathology, Oxford.

Trevor I. Williams
Royal Institution, Albemarle Street,
London, W.1.

[1] Bacharach, A. L., *Nature*, **160**, 640 (1947).
[2] Chain, E., Florey, H. W., Gardner, A. D., Heatley, N. G., Jennings, M. A., Orr-Ewing, J., and Sanders, A. G., *Lancet*, ii, 226 (1940).

THE Petri dish technique for the microbiological assay of vitamins described by Mr. Bacharach[1] has been used in these laboratories for demonstration purposes since September 1946, and the disadvantage to which he refers, namely, the lack of sensitivity, can be fully confirmed.

The general technique we have employed follows closely that used for the cup-plate assay of penicillin. The suspension for inoculum is prepared exactly as for a riboflavin assay by the usual method, except that the cells are suspended in the original volume of saline and used without further dilution. To 12·5 ml. of the melted medium at 45° C., 1 ml. of this strong suspension is added, and the flasks are held at 45° C. for 10 min. before pouring the plates. If a weaker inoculum is used, or the heating at 45° C. is omitted, the zones are less sharp and, in consequence, more difficult to read. Five cups are cut in each plate, and previously sterilized solutions of riboflavin containing 25, 12·5, 6·25, 3·125 and 1·56 μgm./ml. are distributed into the cups in approximately 0·05 ml. amounts. We can confirm Mr. Bacharach's observation that the zone diameter is proportional to the logarithm of the dose, as exemplified on the accompanying graph.

If further research makes it possible so to increase the sensitivity that the technique is suitable for the routine assay of riboflavin in foodstuffs, it will be interesting to examine the influence, on the sizes of the zones, of non-specific growth stimulants which are a source of difficulty with the assay of riboflavin as at present carried out. Since, in the Petri dish assay, the *diffusion* of the vitamin is a factor determining the magnitude of the response, it may be that stimulants of higher molecular weights than the vitamin under test will be without effect on an assay of this type.

Nevertheless the method is even now not without practical applications, as, for example, in demonstrating the qualitative and to some extent the quantitative differences between organisms with regard to their abilities to synthesize a given growth-factor. Instead of cutting cups in the bulk-inoculated, solidified riboflavin-free medium, the surface may be seeded in three or four places with suspensions of bacteria or mould-spores. Those organisms capable of synthesizing the vitamin may then be readily detected by the appearance of circular 'zones of exhibition', the diameter of the latter serving as an index of the amount synthesized. It is suggested that this might be an expeditious way of conducting a survey of organisms in order to differentiate them in this respect.

An obvious point of difficulty is the possibility of widely different requirements of the 'indicating' bacterium and the organisms under test, not only nutritionally but also with regard to *p*H and temperature. We have so far used only the usual basal media developed for microbiological assay (solidified with 1·5 per cent agar) and *Lactobacillus helveticus* and *Lactobacillus arabinosus* for the detection of riboflavin and nicotinic acid respectively. Such media permit growth of, and vitamin synthesis by, many moulds at 37° C., although they are scarcely likely to be optimal for this purpose. The ideal to be aimed at would be a medium and conditions of growth as nearly as possible optimal for both the indicating and the test organisms.

Pontecorvo[2] has described a technique, in some respects similar, for the identification of the nutritional requirements of a mutant, based on the addition of crystals of nutrilites to plates of 'minimal' medium inoculated with the mutant strain. The procedure outlined above, however, serves a different purpose, namely, the investigation of the synthesizing abilities of a range of organisms with respect to a given nutrilite.

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[1] *Nature*, **160**, 640 (1947).
[2] *Proc. Nut. Soc.*, **5**, 182 (1947).

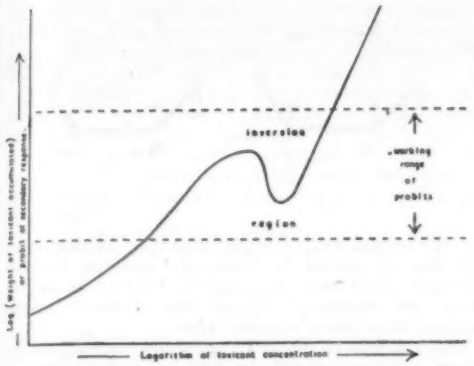
Primary and Secondary Responses in Biological Assay

IT has already been shown that the irritant and paralysing effects of the pyrethrins are of material influence in determining the dose of insecticides accumulated by flying insects in pyrethrum-bearing sprays[1].

The influence of such primary responses on the dose of toxicant accumulated, and thus on the resulting secondary response (usually estimated as proportionate mortality), is now widely accepted as of importance in this system, and the purpose of this communication is to suggest that similar factors may be of more common occurrence in biological assay systems than is generally appreciated, and in particular to indicate their probable influence in fungicidal assay.

Dimond *et al.*[2] reported that tetramethyl thiuram disulphide tested as a fungicide against *Macrosporium sarcinæforme* yields a dosage-response curve exhibiting a maximum and a minimum. They offered an explanation, based on the spontaneous dissociation of the fungicide, which Finney[3] has shown could not account for the observed action without the additional hypothesis of drug antagonism between the two states of the molecule. Montgomery and Shaw[4] also criticized the dissociation hypothesis on physico-chemical grounds, and found similar effects, which they termed 'inversion', in the dosage-response curves for five thiuram and five dithiocarbamate derivatives tested against *Venturia inæqualis*. Parker-Rhodes[5], applying the theory of variability to both types of fungicide, demonstrated that absorption is necessarily preceded by reaction with the spore secretion.

The spray pick-up/toxicant concentration curves previously published for the flying insect system[1] may be converted into log (toxicant pick-up)/log (toxicant concentration) curves of the type shown



THEORETICAL FORM OF DOSAGE RESPONSE CURVE IN SYSTEMS WHERE PRIMARY RESPONSES INFLUENCE THE DOSE ACCUMULATED BY THE RESPONDING POPULATION

in the diagram. It has been pointed out to me by A. Stringer that such curves are quite general in that they can be derived empirically for systems where the toxicant pick-up, and hence the probit secondary response, is not a monotonic function of the applied dosage because of the influence of primary responses.

The probit response and log (toxicant pick-up) are interchangeable as ordinates, using an arbitrary scale ratio, when the probit of an observed response is proportional to the log (effective dose) expected to produce that response.

Since the working range of secondary response probits covers the region of the probit response/applied dosage curve most influenced by the primary responses, the relevant portion of the curve shown here is analogous to that obtained by Dimond *et al.*, whose data are fitted as well by a curve of this form as by that of the authors.

Wain and Wilkinson[6] observed that suspensions of spores dissolve about twice as much copper from Bordeaux mixture as filtrates from the same number of spores, and that the free secretion present in the former does not increase materially on standing in the absence of the fungicide. These facts indicate that further secretion takes place as a primary response to the fungicide, and the application of this general hypothesis to the observations of Parker-Rhodes completes the analogy outlined above.

While this interpretation does not necessarily conflict with the general construction for this system by Finney[3], it does suggest that the postulate of linearity for the regression lines outside the inversion region, made on statistical grounds, may be misleading. No reasonable transformation will consistently reduce the lower dosage end to linearity, and the high-dosage end is linear because the rate of inactivation of the test organism tends to become independent of the applied toxicant concentration. Interpretation of the curve in terms of tolerance distribution is therefore meaningless.

The statistical treatment of data from such systems is being developed; but it may be noted here that probit analysis assumes the linearity of the transformed response with respect to some monotonic function of the toxicant concentration. Such methods, applied to the systems under discussion, will give rise to estimates of relative potency and heterogeneity which are invalid and will frequently be misleading.

I am indebted to Dr. A. B. P. Page for his interest in and discussion of this note.

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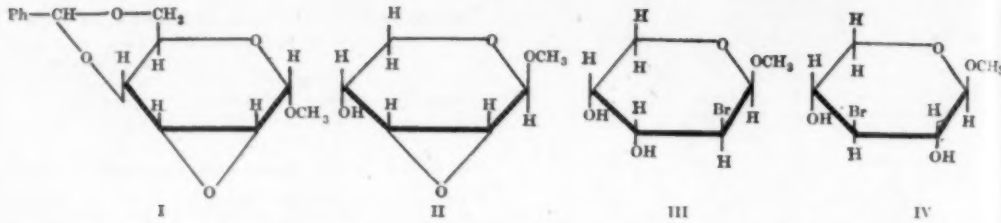
Conversion of *D*-Arabinose into 2-Deoxy *D*-Ribose and 3-Deoxy *D*-Xylose

2-DEOXY *D*-ribose is of considerable importance since it is the carbohydrate constituent of the deoxyribonucleic acid of cell nucleal material, and we have been interested in its preparation for structural and synthetic studies. Although we have made some improvements in the standard method of its synthesis from *D*-arabinal, we are exploring alternative routes. A possible method resulted from the work of Newth, Overend and Wiggins[1] on the ring scission of 2 : 3-anhydro 4 : 6-benzylidene α-methyl alloside (I) with halogen acids, because hydrobromic acid in aqueous acetone solution effected scission of the anhydro ring in this substance to give 2-bromo α-methyl altroside (one part) and 3-bromo α-methyl glucoside (4 parts). On this finding it was clear that a similar ring scission of 2 : 3-anhydro β-methyl *D*-riboside (II) would give rise to 2-bromo β-methyl *D*-arabinoside (III) and 3-bromo β-methyl *D*-xyloside (IV), although it is our experience[2] that, as yet, it would be inexpedient to predict the relative proportions of the isomers that could be produced in this reaction. The halogen sugars (III) and (IV) on reductive dehalogenation would afford 2-deoxy β-methyl *D*-riboside (arabinoside) and 3-deoxy β-methyl *D*-riboside (xyloside). Thus if 2-bromo β-methyl *D*-arabinoside (III) was the main product of the ring-opening of 2 : 3-anhydro β-methyl *D*-riboside, this procedure would furnish a new method of preparation of 2-deoxy β-methyl *D*-riboside and of 2-deoxy *D*-ribose itself. We have found, however, that (III) was only the minor constituent of the ring-scission products, 3-bromo β-methyl *D*-xyloside being the main product. We have, however, obtained 2-deoxy β-methyl *D*-riboside and 2-deoxy *D*-ribose by this procedure, although the method clearly has no preparative value.

2-Tosyl 3 : 4-monoacetone β-methyl *D*-arabinoside (since described by Honeyman[3]) was converted into 2-tosyl β-methyl *D*-arabinoside, which gave on mild alkaline hydrolysis crystalline 2 : 3 anhydro β-methyl *D*-riboside (II), m.p. 45° $[\alpha]_D^{23}$ — 35·8 in chloroform (*c*. 0·6) (cf. ref. 3). Treatment of the anhydro derivative (II) with hydrobromic acid in aqueous acetone gave two halogenated sugar derivatives; a crystalline substance, 3-bromo β-methyl *D*-xyloside (nine parts) (IV), m.p. 95° $[\alpha]_D^{19}$ — 16·4 in methyl alcohol (*c*. 0·36) and a liquid which was mainly 2-bromo β-methyl *D*-arabinoside (III) (one part). The latter substance on hydrogenation in the presence of Raney nickel and calcium hydroxide was converted into 2-deoxy β-methyl *D*-riboside, which gave a strongly positive Dische diphenylamine test[4] for 2-deoxy ribose. The glycoside, on hydrolysis with *N*/100 acetic acid, was



I II III IV

converted into the free sugar 2-deoxy *D*-ribose, which was isolated in the form of the crystalline anilide. This was identical with a specimen obtained from authentic 2-deoxy *D*-ribose[5].

The designation of (IV) as 3-bromo β-methyl *D*-xyloside rests only on theoretical considerations. Some additional evidence comes, however, from the fact that on hydrogenation IV gave a deoxy β-methyl pentoside (3-deoxy β-methyl *D*-xyloside), b.p. 100/0·2 mm. (characterized as the crystalline bis 3 : 5-dinitrobenzoate, m.p. 157°), which gives a completely negative Dische test, a test which on the basis of the work of Deriaz, Stacey, Teece and Wiggins[5] is given only by 2-deoxy pentoses or readily hydrolysable derivatives thereof.

This work and further structural studies will be published in detail elsewhere.

Note. After the completion of this investigation it came to our notice that the synthesis of 3-deoxy *L*-xylose from 2 : 3 anhydro β-methyl *L*-riboside has been achieved in Prof. A. R. Todd's laboratory by different methods[6].

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Scattering of D—D Neutrons by Deuterium

Massey and Buckingham[1,2] have pointed out that a study of the collisions of neutrons with deuterons can be expected to throw light on the nature of the nucleon forces even when the neutron energy is comparatively low. In a recent survey[1] of experimental data, they conclude that the evidence is in favour of exchange forces. It seems worth while, therefore, to report some experiments which give support to ordinary, rather than exchange, forces.

The tracks of 1,500 recoils from D—D neutrons of 2·53 MeV. energy have been photographed in a cloud chamber filled with heavy methane to an (expanded) pressure of 1·1 atmosphere, and those tracks were measured which started from points from which no track could pass out of the illuminated region.

Selection of tracks for a statistical count of number *vs.* angle was made by the method of Dee and Gilbert[3], in which only those tracks are counted the length and angle of projection of which are close to satisfying the theoretical range – angle relation. In this work the allowed spread in range was greater, because neutrons could enter the chamber during, as well as after, the expansion, though the observed results indicate that most entered after.

The numbers of tracks in equal intervals of cos 2φ, where φ is the angle of projection of the deuteron in room co-ordinates, were counted and plotted against the corresponding values of $(180 - 2\varphi) = \theta$ to give the number of neutrons scattered per unit solid angle in the direction θ, measured in centre-of-gravity co-ordinates (see table). A few long tracks attributed to recoil protons were observed and a correction was made at the larger recoil angles where allowed bands for protons and deuterons would overlap. The mean number of long tracks in the first three intervals was taken as the number to be expected in each interval, and the correction was obtained by multiplying this number, 10, by the ratio of the overlap area to the allowed deuteron area in each interval. A random track correction, for tracks produced by neutrons not coming directly from the source but yet lying within the allowed length – angle band, was made by subtracting a number proportional to the number of tracks observed just outside that band. The results are shown in the accompanying table.

Interval	Cos 2φ	No. of tracks	Proton correction	Random correction	Corrected number	'Standard deviation'
1	1 –0·8	217	0	26	191	11·7
2	0·8–0·6	134	0	15	119	10·0
3	0·6–0·4	109	0	17	92	9·0
4	0·4–0·2	74	1	13	60	7·4
5	0·2–0·0	51	2	18	31	5·5
6	0·0– –0·2	72	3	14	55	7·1
7	–0·2– –0·4	74	5	24	45	6·5
8	–0·4– –0·6	103	5	27	71	8
9	–0·6– –0·8	68	6	9	53	7

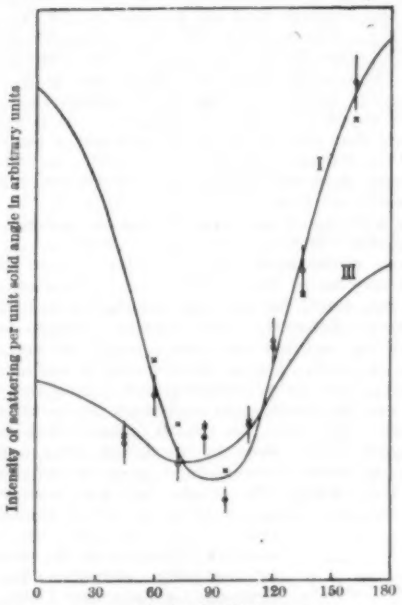
The 'standard deviation' of the corrected numbers given in the table was calculated from the formula $\sigma = Npq$, where N is the total number of tracks, p is the probability that a track will lie in a particular angle interval and q is $1 - p$, for a uniform binomial distribution. In this case p is different for each interval, and the best estimate of p was taken to be the ratio of the number of tracks observed in an interval to the total number, so that the formula became

$$\sigma_i = n^{1/2}\left(1 - \frac{n_i}{N}\right)^{1/2} \qquad i = 1, 2 \ldots 9.$$

The random track correction is rather large and makes so great a difference to the distribution obtained—ratio of interval 1 to interval 5 is about 4 : 1 before correction and about 6 : 1 after—that the

precision of the determination must be considered to be low. The track-lengths in interval 9 were less than 5 mm. and some could have been missed. The value given may be taken as a lower limit.

The distribution found shows qualitative agreement with that found by Kruger, Shoupp, Watson and Stallmann[3] and Coon and Barschall[4], but indicates a greater change between $\theta = 180°$ and $\theta = 90°$ than either, and a less sharp maximum in the forward direction than found by Coon and Barschall.



THEORETICAL DISTRIBUTION CURVES I (ORDINARY FORCES) AND III (EXCHANGE FORCES) CALCULATED BY BUCKINGHAM AND MASSEY

—×—, observed uncorrected points, adjusted to agree with curve I near 120°.

—○—, observed points after corrections have been applied, adjusted to agree with curve I near 120°, and showing twice 'standard deviation'.

The distributions to be expected on the assumptions of ordinary and exchange forces have been calculated by Buckingham and Massey[6] and are reproduced in the accompanying graph. Our data—ignoring point 9—fit the curve for ordinary forces very closely. Experiments are being continued with lower gas pressures in the attempt to study the distribution at small angles with greater precision.

We wish to thank Prof. L. H. Martin for continual advice and encouragement. The work was made possible by a grant from the Council for Scientific and Industrial Research.

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Treatment of Glass and Steatite Ceramic with Quaternary Ammonium Compounds for the Improvement of Electrical Insulation Resistance

THE adsorption and condensation of water on the surface of insulators was responsible for the failure of much electrical equipment under service conditions in the tropics. From the literature of flotation[1], it was known that the adsorption of a unimolecular film of an amphipathic (polar – non-polar) compound gives to solid surfaces a paraffin-like character, rendering them less readily wetted by water. Some typical flotation reagents were therefore applied to glass and steatite ceramic surfaces in an endeavour to improve their electrical insulation resistances under moist conditions. As might be anticipated from the work of Wark[2], the quaternary ammonium compounds were effective. The accompanying table shows the results obtained with various substituent radicals for glass microscope slides and steatite terminal bushings. These were cleaned with chromic acid, immersed for about one second in an aqueous solution of the quaternary ammonium salt, and then washed thoroughly in distilled water.

Quaternary ammonium salt (10^{-4} *M* solutions used for treatment except where otherwise indicated)	Insulation resistance (megohms) measured *in situ* after 2 days at 98–100 per cent relative humidity and 30° C.		Contact angle with water for the treated glass
	Glass microscope slides (double contacts 1 in. in length, 1 in. apart)	Steatite terminal bushings (min. leakage path, 0·3 in.)	
Control samples (cleaned with chromic acid)	5×10^3	7×10^3	0°
Decyl-trimethylammonium bromide	4×10^3	4×10^3	0°
Dodecyl- " "	4×10^3	1×10^4	0°
Tetradecyl- " "	7×10^3	3×10^4	40°
Cetyl- " "	5×10^4	7×10^4	55°
Octadecyl- " "	2×10^5	1×10^5	54°
Ceryl- " "	1×10^5	4×10^4	55°
Cholestanyl- " (10^{-6} *M*)	4×10^3	4×10^3	60°

The surface of glass in contact with an aqueous medium is negatively charged[3] and therefore attracts cations present in the medium. If amphipathic cations are present, they become oriented so that the polar groups are turned towards the glass surface[4,5]. Whereas hydrogen ions and metal ions at the surface are continuously exchanged with cations in the bulk of the solution, the diffusion of amphipathic cations from the surface back into the solution is hindered as a result of the cohesion of the non-polar groups. If this cohesion is sufficiently great, it leads to the formation of a stable monolayer of quaternary ammonium ions in which the outward orientation of the non-polar groups reduces the attraction of the surface for water. The results given in the table indicate that, for the treatment of glass with alkyl-trimethylammonium bromides under the conditions described, alkyl substituents of chain-lengths greater than fourteen carbon atoms give sufficient cohesion for the formation of stable adsorbed layers.

The replacement of the alkyl substituent by a cholestanyl group gives slightly better results, probably because the minimum area subtended by the latter at a glass surface is more nearly equal to that of the trimethylammonium head-group.

A more complete report on these experiments will be given elsewhere.

We are indebted to Dr. I. W. Wark, chief of the Division of Industrial Chemistry, and to Mr. K. L. Sutherland, Division of Industrial Chemistry, for the original suggestion regarding the use of cationic surface-active substances for the treatment of glass and steatite, and for subsequent helpful suggestions. Thanks are also due to Dr. D. M. Myers, chief of the Division of Electrotechnology, for his continued interest in, and encouragement of, this work.

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Oct. 16.

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Abnormalities in the *F*-Region of the Ionosphere at Calcutta

Ionospheric observations carried out for more than two decades have clearly established the existence of correlation between the variation of electron contents of the different ionospheric layers and solar activity. It has been found that there is a general increase in the ionization density during the period of maximum sunspot numbers. This general increase, as expected, has also been noticed during the present phase of maximum solar activity in the routine ionospheric observations made at the Wireless Laboratory of the University College of Science, Calcutta. Besides this general increase, however, certain peculiar features of the diurnal variation of the ionization density have also been observed.

Figs. 1–3 depict the monthly mean diurnal variation of Region *F* ionization for the months of January 1946 and January 1947 for Madras (lat. 13° N., long. 80° 13′ E.), Calcutta (lat. 22° 33′ N., long. 88° 21′ E.), and Delhi (lat. 28° 35′ N., long. 77° 5′ E.) respectively. (For Calcutta the curve for 1945 is also given. The curves for Delhi and Madras are drawn from data kindly supplied by All India Radio.) It is at once noticed that there is a general increase of ionization at all the stations. The stations Calcutta and Madras, however, show another peculiar feature which is not noticeable at Delhi or at Slough (Fig. 4). A comparison of Figs. 3 and 4 shows that the general trend of diurnal variation for January 1947 at the two stations is the same and is similar to that for the previous year at Delhi. The trend of variation for the same month for Calcutta and Madras is, however, markedly different. The ionization begins to rise sharply at daybreak and attains nearly the maximum value at about 11 a.m. In the case of normal solar activity, this value is maintained during the whole day and the decrease in ionization begins nearly at sunset. But for the month under consideration (January 1947, phase of maximum solar activity) the peak value is maintained more or less constant not only during the whole day but even up to the evening hours, 9–10 p.m. It is remarkable that there should be such marked difference in the character of ionization variation for two stations, Calcutta and Delhi, situated at not very different geographic latitudes. The difference in the magnetic dip values at the two stations is, however, comparatively larger, and one is tempted to associate the characteristic difference in ionization variation of the two stations as due to some geomagnetic control of the ionosphere[1], to the existence of which attention was first directed by Appleton[2].

Fig. 1

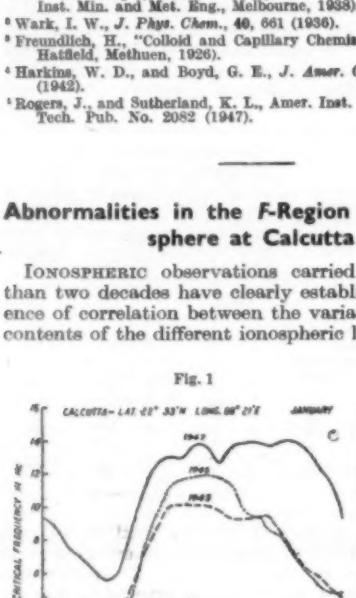
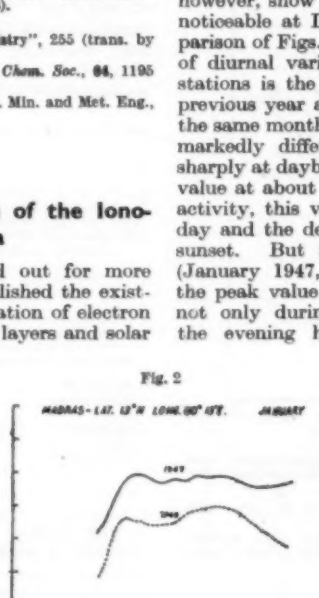


Fig. 2



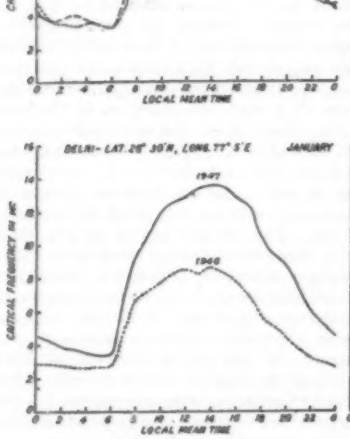


Fig. 3

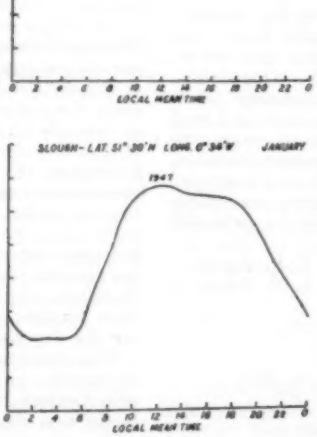


Fig. 4

The investigations described above form part of a programme of research of the Radio Research Committee of the Council of Scientific and Industrial Research, India. We thank the Director of Scientific and Industrial Research for permission to publish the note.

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Measurement of High Permittivity Values at Centimetre Wave-lengths

CERAMIC materials with permittivity values up to several thousand are now available. The measurement of permittivities of this order provides little difficulty at normal radio frequencies, but measurements have not been made, so far as I am aware, at frequencies of the order of 10^{10} c./s. ($\lambda = 3$ cm.)[1], in which frequency region the materials are likely to find increasing application. For this purpose the experimental technique illustrated in Fig. 1 has been developed. A specimen of the material is placed in a coaxial line or wave-guide (completely filling the dielectric space) and is followed by a non-reflecting termination. The energy transmitted through the specimen is measured at A, for constant incident energy, as the wave-length of the energy source is varied.

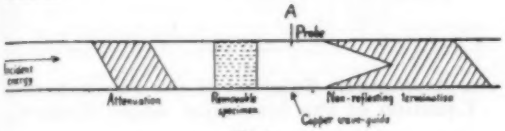

Fig. 1

Two sets of experimental results obtained in an H_{01} wave-guide system over the frequency range $8{\cdot}1 \times 10^9 - 10^{10}$ c./s. ($\lambda = 3{\cdot}7 - 3{\cdot}0$ cm.) are shown by the points in Fig. 2. The results marked ● and ○ relate to specimens of permittivity, as measured at $1{\cdot}5 \times 10^9$ c./s. of 25·8 (zinc orthotitanate) and 91·2 (rutile), and of thicknesses 1·810 and 2·140 cm., respectively. The curves (a) and (b) show the variations of transmitted energy determined theoretically for assumed permittivity values of 26·0 and 91·0. It will be seen that the peaks become sharper and move closer together, for a given length of specimen, as the permittivity increases, and that in both cases they are sufficiently sharp to afford an accurate permittivity evaluation from the experimental results. The peaks, in fact, disappear in the limiting case of infinite permittivity, since it may be shown that

$$\frac{\text{width of peak}}{\text{peak separation}} \sim \frac{1}{\sqrt{\varepsilon}} \quad \text{for large } \varepsilon.$$

The occurrence of peaks necessitates great accuracy in the preparation of the faces of the specimens, and causes considerable experimental difficulty in the usual methods of permittivity measurement.

Dielectric loss in the specimen causes a reduction in height of the peaks, but this effect is apparently not significant in the results shown.

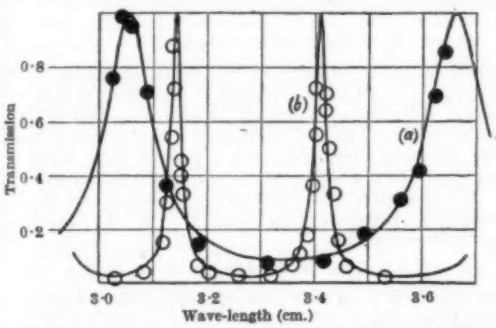

Fig. 2. EFFECT OF PERMITTIVITY ON SHARPNESS OF PEAKS
Curve a: $\varepsilon = 26{\cdot}0$; $b = 1{\cdot}81$. Curve b: $\varepsilon = 91{\cdot}0$; $b = 2{\cdot}14$

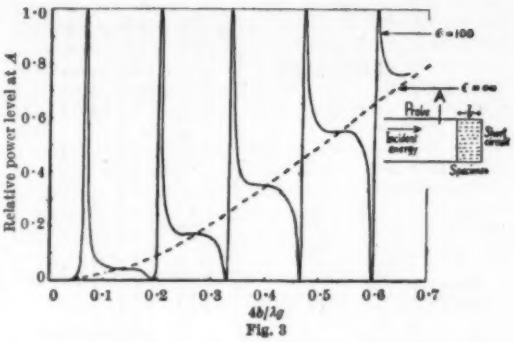

Fig. 3

The behaviour approaches that of a perfect metal as ε increases. This is demonstrated more clearly in the variation of the power-level at a fixed point in front of a specimen, when backed by a short circuit, as the length of the specimen, b, or the wave-length of the incident energy is varied. The calculated effect with this arrangement and a specimen of permittivity 100 is shown in Fig. 3 as a function of $4b/\lambda_g$, where λ_g is the wave-length in the air-filled guide. The dotted curve shows the behaviour for a metal specimen (that is, the limiting case as $\varepsilon \to \infty$).

The curves of Fig. 2 are reminiscent of the Fabry–Perot interference fringes, and, in fact, both are due to the presence of a pair of parallel, highly reflecting surfaces. The analogy between the effect with light and that described here with centimetre waves is very close.

The arrangement could be used as a highly selective filter, the response being of normal Q curve form with the 'Q value' proportional to the permittivity.

Experiments are in progress on materials with much higher permittivities than those referred to in Fig. 2, and the work will be reported fully when these are completed.

I am indebted to Dr. D. F. Rushman, of the Mullard Radio Valve Co., for providing suitable ceramic materials.

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A hint is given of measurements at 3×10^9 c./s. in a paper by von Hippel, *Ind. Eng. Chem.* (Nov. 1946).

Photo-electric Counting of Individual Microscopic Plant and Animal Cells

A PHOTO-ELECTRIC apparatus for counting individual microscopic cells in fluid suspension has been constructed in this laboratory. A sufficiently large signal-to-noise ratio from a single cell or a part of it has been obtained by the use of a specially designed dark-field system and an *RCA* 931-*A* multiplier phototube. The phototube is followed by an amplifier which operates a mechanical counter. As it was not possible to arrange the cells in one line in a capillary space, a scanning method using an ordinary counting chamber was evolved.

The optical arrangements are shown in Fig. 1. A circular aperture, A, is projected by a reversed microscope objective, O_B, in such a way that the diminished image, which has about the same size as a cell, is

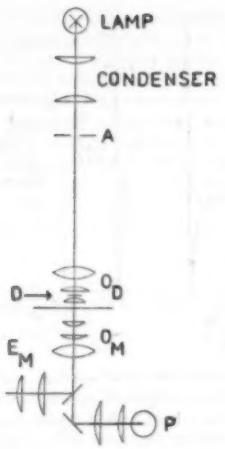

Fig. 1

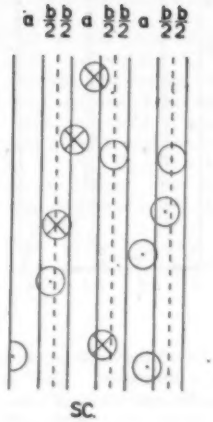

Fig. 2

focused on the plane where the cells are situated. By means of an opaque circular diaphragm, D, placed behind the front lens and covering the central part of the lens surface, the objective, O_D, also acts as a dark-field condenser. By these means the projected image of the circular aperture, A, is invisible and latent so long as the field is optically homogeneous. When a cell or part of it is inside the effective area of the latent spot, the light is reflected and refracted so that light from the latent spot reaches the objective of the microscope, O . The light emerging from this objective is divided by means of a double ocular into two parts, one part falling into the phototube, P, and the other falling into the ocular, E_M, through which the object plane may be observed.

When the counting chamber with the cells is moved, the latent spot meets successively cells or parts of them which now become luminous and are recorded by the phototube-amplifier-counter system. The width of the scanning area, which must be known in order to calculate the scanned volume, is derived in the following manner. Fig. 2 shows schematically the cells of an arbitrary field in the counting chamber. a is the effective diameter of the latent spot and b the median value of the cell diameter. The area of the counting chamber is divided by lines parallel to the scanning direction, so that the distance between two adjacent dotted lines is $\frac{1}{2}b + a + \frac{1}{2}b$. This distance is the scanning width. Those cells are counted (crossed in Fig. 2) the centres of which are inside the scanning width (actual scanning track marked *SC*). When the centre of a cell is situated just inside the scanning width, this cell is not counted if the diameter is so much smaller than the median value of the cell diameter which determines the position of the dotted line that the edge of the cell does not reach the effective area of the latent spot. In the same way, a cell which is situated just outside the scanning width is counted if the diameter is so much larger than the median value of the cell diameter that the edge of the cell reaches the effective area of the latent spot. However, the effects of these two groups of cells cancel each other if a large number of cells are counted, because there are as many cells of a diameter greater than the median value as there are cells of a diameter smaller than that value, according to the definition of the median value.

In order to get correct results, it is necessary to have the cells uniformly distributed and the cell suspension free from contamination with foreign particles that can be recorded by the electronic system. These two conditions will decide whether a certain kind of cell can be satisfactorily counted or not by the method described. The method has been applied to the counting of human erythrocytes and yeast cells. The results have been compared with those of the ordinary counting chamber method, and the two methods have been found to agree rather well.

A full account of this work will be published in *Upsala Läkareförenings Förhandlingar*.

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Sept. 11.

An Asymptotic Solution of the Fundamental Equation of the Statistical Atom Theory

THE problem of atoms and ions with spherical symmetry as well as the problem of metals and ionic crystals seems to be dealt with quite satisfactorily by the Thomas – Fermi's statistical method[1], with its modifications due to Dirac[2], Jensen[3] and Gombás[4] respectively. But the fundamental equation of the modified theory having no solution in closed form, that is, in terms of elementary functions, one must apply for its solution, in each particular case, rather lengthy numerical methods. To avoid these difficulties, we propose an asymptotic method of solution which may be applied successfully in many cases.

The fundamental equation may be written in the following form[4]:

$$y'' = x\{(y/x)^{1/2} + \beta\}^2, \qquad (1)$$

and is to be solved under the conditions

$$y(0) = 1 \text{ and } y(x_0) - x_0.y(x_0) = (Z-N)/Z, \qquad (2)$$

where Z, N and x_0 denote respectively the atomic number, the number of the electrons and the atomic radius; β depends also on Z.

In the particular case $\beta = 0$, (1) reduces to the original equation of Fermi, which has been solved by Fermi[1], Sommerfeld[5] and Miranda[6].

In a previous paper we have attempted to solve (1) by the method of perturbations. By considering β as a perturbation parameter, we have sought the solution in the form of a power series

$$y = y_0 + \beta y_1 + \beta_0 y_2 + \ldots,$$

where y_0 is the solution of the Fermi equation. For $y_1, y_2, \ldots$ we have obtained a recursive system of linear differential equation, which may be solved quite easily. The only difficulty which arises is that the resulting series does not converge very rapidly, and one has to calculate, therefore, several terms.

We can avoid this difficulty by making use of the following method. In case $\beta = 0$, (1) has the particular solution

$$y = 144/x^3. \qquad (3)$$

In case $\beta \neq 0$ we may seek, therefore, the solution in the form

$$y = 144/x^3.v(x). \qquad (4)$$

For $v(x)$ we obtain the equation

$$\frac{1}{12}x^2v'' - \frac{1}{2}xv' + v = \left\{v^{1/2} + \frac{\beta}{12}x^2\right\}^2.$$

For $v(x) = w(x^2) = w(t)$ we have then

$$\frac{1}{3}t^2w'' - \frac{5}{6}tw' + w = \left\{w^{1/2} + \frac{\beta}{12}t\right\}^2. \quad (5)$$

Putting $w(t) = 1 + c_1t + c_2t^2 + \ldots$ we obtain, by comparing coefficients:

$$c_1 = -\frac{3}{16}\beta,\ c_2 = \frac{79}{9216}\beta^2,\ c_3 = \frac{1584}{63700992}\beta^3,\ \ldots$$

Thus we have the solution

$$y = \frac{144}{x}(1 + c_1x^2 + c_2x^4 + c_3x^6 + \ldots), \quad (6)$$

and the series converges rapidly, for it is majorized by the geometrical series with the quotient 10^{-3}. We may stop, for example, at the third term.

The shape of our curve is the same as that calculated by Jensen's numerical method. Our solution does not satisfy the condition $y(0) = 1$. We can avoid the difficulty by using an idea of Sommerfeld[5], namely, we put

$$y \sim \frac{144}{\{1 + (x/a)^2\}^{3/2}a^3}\{1 + c_1a^2\{1 + (x/a)^2\} + \ldots + c_2a^4\{1 + (x/a)^2\}^2\}. \quad (7)$$

This function is asymptotically equal to (6), and the parameter a may be chosen such that the condition $y(0) = 1$ be satisfied.

This asymptotic solution, as well as Sommerfeld's, yields a very good approximation, especially in the exterior parts of the atoms.

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Brightness of the New Moon

I have been unable to find in the literature any data for the brightness of the new moon. This can be calculated in two independent ways.

(1) The earth receives from the sun at noon about 10^5 lux[1]. The albedo value of the earth is about 45 per cent[2]. The brightness of the earth, as seen from a great distance, is therefore $4{\cdot}5 \times 10^4$ apostilb (equivalent metre candles) or $1{\cdot}43 \times 10^4$ c./m.^{2}. The cross-section of the earth is $1{\cdot}27 \times 10^9$ km.^{2}, or $1{\cdot}27 \times 10^{14}$ m.^{2}. The candle-power of 'full earth' is therefore $1{\cdot}82 \times 10^{18}$ c. The distance earth to moon being $3{\cdot}84 \times 10^8$ m., the latter receives from the earth 12·3 lux. The illumination on the earth at full moon being only 0·2 lux[1], the illumination-level on the moon at 'full earth' is consequently about sixty times better.

The albedo value of the moon is about 7·3 per cent[3]; therefore, the brightness of the new moon is 0·86 apostilb or $2{\cdot}7 \times 10^{-5}$ stilb (candle per sq. cm.).

(2) The earth receives at full moon 0·2 lux. The surface of the earth is 15·1 times that of the moon. The earth reflects 6·2 times as well as the moon. Because the sun sheds the same number of lux on the earth as on the surface of the moon, the moon receives at full earth $15{\cdot}1 \times 6{\cdot}2 \times 0{\cdot}2$ lux or 18·7 lux. The moon reflects 7·3 per cent. The brightness of the new moon is thus 1·37 apostilb or $3{\cdot}6 \times 10^{-5}$ stilb.

Both methods lead thus to a value of about 3×10^{-5} stilb or about 1 apostilb. The brightness of full moon is about 0·3 stilb or 10,000 times higher.

With the aid of a formula given by P. J. Bouma[3] the brightness of the new moon can be converted into magnitudes and is equal to $-2{\cdot}4$, whereas for the full moon the magnitude is $-12{\cdot}5$.

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[2] Schönberg, E., *Erg. exakt. Naturwiss.*, **5**, 6 (1926).
[3] *Philips Tech. Rev.*, **5**, 308 (1940).

Darkening of Red in Protanopes

The degree of darkening of the Ilford Spectrum Red colour-filter was measured for twelve protanopes and compared with its brightness for eighteen deuteranopes and several hundred normal subjects. The light transmitted by the red filter from a daylight source was mixed with light transmitted by the Ilford Spectrum Green filter and matched for brightness against light transmitted by the Ilford Spectrum Yellow filter by varying the intensity of the yellow. The mean brightness-level for the eighteen deuteranopes was the same as for normal subjects for all red-green mixtures. For the twelve protanopes the red light was only 15·5 per cent as bright on the average as for normal subjects; but the brightness-level steadily increased as green was added, until it reached the normal level at the pure green end.

At the extreme red end of the scale, the scatter of brightness measurements for the twelve protanopes did not overlap the scatter for the eighteen deuteranopes. No calculations are necessary to show that we are dealing with two groups of subjects which are statistically distinct.

This experiment confirmed the view put forward previously[1] that the Ishihara Test for colour blindness fails to distinguish clearly between protanopes and deuteranopes. Of the eighteen deuteranopes who did the present experiment, fourteen also did the Ishihara Test, which failed to distinguish five of them clearly from protanopes. Similarly, nine of the twelve protanopes also did the Ishihara Test, and it failed to distinguish eight of them unequivocally from deuteranopes, although the evidence for this distinction based on actual measurements of the darkening of the red is very clear indeed. It is interesting that Geddes[2], assuming the validity of the Ishihara Test, makes a separate class ('incompletely red-green blind') for those subjects not decisively placed as protanopes or deuteranopes (that is, scoterythrous or photerythrous) by that test.

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Oct. 23.

[1] Pickford, R. W., *Nature*, **153**, 656 (1944).
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Effects of Calcium Deficiency on Potato Sets in Acid Soils

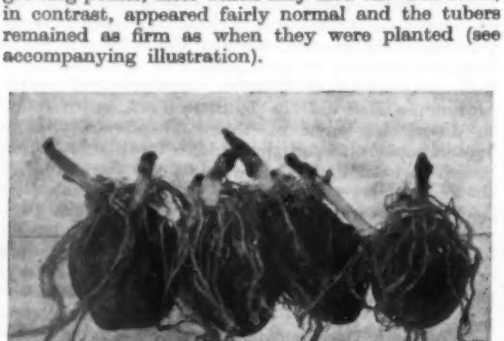
DURING the War, when many poor upland areas and commons in Britain were ploughed up for crop production, potatoes were commonly planted as a first crop in view of their tolerance to acid soil conditions. Many failures, however, were experienced where the soils were very strongly acid, with *p*H values of the order of 4·0, and it was shown that liming was necessary to correct the unfavourable conditions. Plants which survived on these acid soils usually showed pronounced symptoms of calcium deficiency in the haulms, and it was clear that the supply of this element was an important factor in determining success or failure of the crops.

A second point which was noted where the shoots failed to emerge, and which has so far remained unexplained, was that the planted tubers remained firm and apparently failed to make any shoot growth. This phenomenon appeared unusual, since tubers will sprout and soften normally in the absence of any soil, and seemed to suggest an inhibiting effect on shoot-growth, such as might result from toxic substances in the soil, as, for example, excess of hydrogen ions, manganese, aluminium or ammonium.

In the course of sand-culture experiments carried out at Long Ashton, in which the effects of possible soil-acidity factors have been examined on a number of crop plants[1,2], observations have been made on potatoes which indicate that the effect is a direct result of calcium deficiency and is not due to the toxic action of elements present in excess.

Sprouted potato sets, variety Majestic, were grown in sand, with and without calcium, both pots and sand being specially treated to ensure very acute conditions of calcium deficiency where the element was omitted from the nutrient solutions. Differential nitrogen treatments, including nitrate, ammonia and urea, were given, and some cultures also received concentrations of manganese and aluminium sufficiently high to produce severe toxic effects. Two series of parallel nutrient solutions, with *p*H values of 3·5 and 5·5, were used.

In the cultures from which calcium was omitted, the plants failed completely and the shoots did not emerge above the level of the sand. On examining the tubers of these plants, it was found that the sprouts had broken down immediately behind the growing points, after which they died off. The roots, in contrast, appeared fairly normal and the tubers remained as firm as when they were planted (see accompanying illustration).



SPROUTED SETS, SHOWING DEATH OF GROWING POINTS RESULTING FROM CALCIUM-DEFICIENCY TREATMENT IN SAND CULTURES

The affected tubers were afterwards thoroughly washed; then they again sprouted normally in boxes without sand or soil.

In all cultures to which calcium was given the shoots emerged normally, and it was not until a later stage of growth that signs of the other unfavourable treatments were developed.

It thus seems that the hard-tuber condition which occurs in failure-plants on acid soils results from the dying back of the young shoots prior to emergence above the soil, and that this is caused by deficiency of calcium and is not due to the effects of toxic concentrations of elements such as manganese and aluminium.

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Long Ashton Research Station,
University of Bristol. Sept. 13.

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Transmission of a Disease Resembling Virus Yellows through the 'Seed' of Sugar Beet

IN the course of breeding experiments, Mr. B. Crombie of the Irish Sugar Co. observed in 1946 that three separate field crops of a new family of sugar beet showed in each case approximately 25 per cent of 'yellowed' plants two to three weeks after singling. He stated that the disease resembled typical virus yellows but did not appear to spread to neighbouring beet crops. The parent plants of the family (No. 41) had been selected from good commercial beet crops in a relatively virus-free district, but no information was available as to their freedom or otherwise from yellows. The cross had been made in 1945 in a pollen-proof cage.

On September 7, 1946, the Sugar Co. transmitted to this laboratory field-plants of family 41 showing yellows, together with a small quantity of the residual 'seed' of this family. (The term 'seed' is used in the popular sense and refers to the fruit clusters.) A portion of the latter was sown in 1946, and the remainder in March 1947, in an insect-proof glasshouse, the seedlings being transplanted to 7-in. pots when of appropriate size. No abnormality was noted until the plants were about 10 in. in height, with ten to twelve foliage leaves, when the tips of the two basal leaves of certain plants became tough, then changed from the normal colour to light green and, gradually, through yellow to orange. As a general rule, the yellowing afterwards spread downwards through the leaves, only the areas around the veins remaining green. Similar symptoms meanwhile developed in the next leaves above, the advance of the disease being thus acropetal. No vein-clearing or other abnormality was detected in the young developing foliage. In some of the affected leaves the yellowing remained confined to the tips with, occasionally, an island of affected tissue midway on the lamina; in others it spread irregularly down one side. Frequently a yellow area was clearly demarcated from a green one by a main vein, this being more noticeable as the plants became older. Eventually the chlorotic areas withered and turned brown and the margins of the leaves curled upwards. Of the 143 plants which were raised from seed, 47·5 per cent showed the foregoing symptoms, which, in general, resemble those of virus yellows as described by Watson[1].

In view of repeated statements that beet yellows virus is not transmissible through the seed, and having regard to the proportion of plants affected in the 1946 field crops of family 41, it had been tentatively assumed that the yellowing might be due to a genetical abnormality rather than to virus infection. However, it has now been established that the disease is transmissible from family 41 to healthy plants of sugar beet and spinach (*Spinacia oleracea* L.) by means of the aphis *Myzus persicæ* (Sulz.). Confining the expression of results to those obtained with plants of family 41 raised from seed in the glasshouse, and thus protected from accidental infection, transmission has now been secured in three separate experiments involving sixty-eight sugar beet and thirty-four spinach seedlings as experimental hosts. Of these, 85 per cent and 76 per cent, respectively, developed yellows, the initial symptoms appearing in the lower leaves three to four weeks after inoculation by the insect vector. In parallel experiments, using as sources of infection field plants of commercial beet and mangold varieties showing typical yellows, a disease was obtained which appeared identical with that occurring in family 41. It is reasonable to assume, therefore, that an ordinary yellows virus was present in at least one of the parent plants of family 41, and that it penetrated the seed resulting from the cross. This new family is possibly unique in being thus susceptible to seed infection; but it is important to know that such a type can arise from the crossing of popular commercial sorts.

Incidentally, there appear to be two types of yellows disease occurring in commercial beet crops, for certain plants selected from the latter yielded a virus (or virus mixture) which invariably produced in the experimental hosts a clearing or superficial necrosis of the veins of the young leaves, this initial symptom being followed by acropetal yellowing as already described.

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[1] Watson, M. A., *Ann. Appl. Biol.*, **29**, 358 (1942).

Possible Significance of Free-living Nematodes in Genetic Research

THE free-living nematodes of the sub-order Rhabditina are widespread in the soil[1] and relatively easily cultivable[2–4] on nutrient agar in the presence of bacteria and have short life-cycles (3–7 days from hatching to sexual maturity), with adult sizes up to 3 mm. in length. They offer, in our estimation, certain very interesting possibilities for the study of basic genetic phenomena—morphological, cytogenetic and physiological.

The particular morphological significance of these forms is related to the phenomenon of cellular constancy, or eutely, which the phylum Nematoda (along with the other aschelminth phyla) exhibits for some or all somatic cells. Therefore, the free-living nematodes, containing at most a few hundred somatic nuclei in cells and syncytia, offer material in which mutations affecting structural components may well be interpretable in terms of cellular morphology, rather than only in terms of organ morphology and gross structure.

The cytology of the sex cells of various species of the genus *Rhabditis* Dujardin (1844) has been studied by a few workers[5–11], and has revealed some very interesting sex-patterns. Diploid numbers of 10–24 chromosomes are known for the females and hermaphrodites of different species; the males, where known, are the heterogametic sex with an *XO* sex-chromosome pattern. Some species are dicœcious, usually with approximately equal numbers of males and females; others are composed of hermaphrodites of female form and much rarer males, or no males at all; and a few consist only of thelytokous females. Certain dicœcious and many hermaphroditic species use their sperm only to initiate development; the sperm confers its centrosome, but not its nucleus, on the ovum[5,7,9]. In some of these species pairing and reduction of chromosomes nevertheless occurs in meiosis; the diploid number is reconstituted with the failure of a second meiotic division to occur. Sex-determination is apparently effected by an unusual regulation of *X*-chromosome behaviour in meiosis. With simple chromosome numbers these forms should be good cytogenetic material; and with their unusual sex-patterns a considerable versatility in the detection and manipulation of mutations should be possible.

Another important consideration is the possibility of studying physiological mutants. As a result of the work of Kidder and Dewey[12] it is now possible to grow at least one organism of animal nutrition (the ciliate *Tetrahymena geleii*) on an almost completely chemically defined medium (consisting of inorganic salts, glucose, vitamins, amino-acids, purines and pyrimidines, and one unknown growth factor). It seems certain that the near future will see a completely known synthetic medium for this form. Through the use of a chemically defined medium the possibility arises that the new concepts of physiological genetics developed by Beadle[13] may be tested on a differentiating organism. Kidder and Dewey's work suggests a valuable lead for the development of a chemically defined medium for species of *Rhabditis*.

We feel that, with eutely, good cytological features, and convenient sex patterns, together with promising cultural and nutritional aspects, the soil-dwelling nematodes offer attractive possibilities for a correlation and precise interpretation of the morphological and physiological genetics of a simple, differentiating organism. Such a simultaneous approach is being attempted in this laboratory. We are presenting the foregoing discussion in the hope of stimulating others to work on the same problem.

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INFLUENCE OF TEMPERATURE ON THE UREA DENATURATION OF β-LACTOGLOBULIN

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THE kinetics of urea denaturation of globular proteins has been little investigated. This is surprising in view of the interesting results obtained by Hopkins[1], who showed that the temperature coefficient of urea denaturation of egg-albumin (60 per cent urea) is negative.

Since unusual features of a chemical process often help in the elucidation of the reaction mechanism, it was thought that a closer investigation of the urea denaturation might be valuable. Unfortunately, a negative temperature coefficient of the egg-albumin denaturation by urea is only found at very high urea concentrations (Clark[2]), which means that the reacting system must be built up from egg-albumin solution and solid urea. Because of the very high initial rate of the reaction, the numerically large temperature coefficient and the large heat consumption due to the dissolution of the urea, an accurate investigation of the denaturation of egg-albumin in high urea concentration seems to be difficult. It was, however, found that the β-lactoglobulin denaturation by urea has a negative temperature coefficient at an appreciably lower urea concentration, namely, 38 per cent. Some results of experiments with this protein are given in the following.

Solutions of iso-electric β-lactoglobulin in 0·1 *N* sodium chloride (*p*H 5·15) and freshly dissolved urea (*p*H 6·95) were mixed in such proportions that the reaction mixture contained 38 per cent urea and 2 per cent β-lactoglobulin. The *p*H of the reaction mixture was 5·17 (hydrogen electrode). The aliquots withdrawn were mixed with 10 volumes of a solution containing 0·8 mol. acetic acid, 0·4 mol. sodium acetate and 0·5 mol. magnesium sulphate. Extensive comparative experiments by Mr. G. Johansen in this Laboratory have shown that of all buffer-salt mixtures tried, this solution gives the highest yield of precipitated (denatured) protein, without precipitating undenatured protein. The precipitate was filtered and washed ten times with the salt-buffer mixture and analysed for nitrogen.

The accompanying curves are based on independent double determinations.

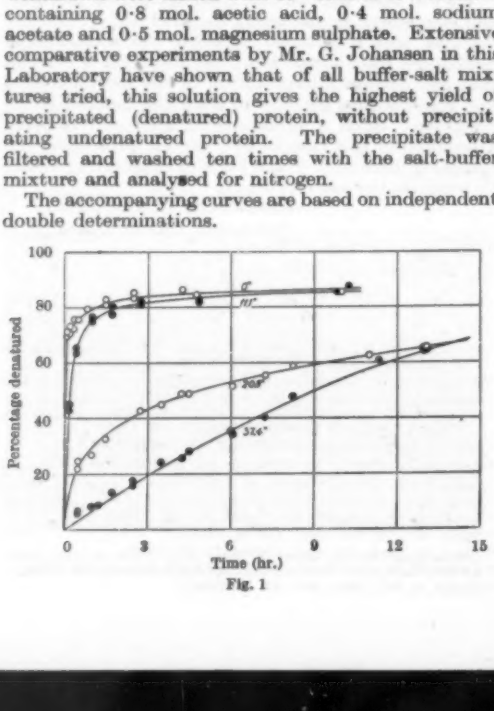

Fig. 1

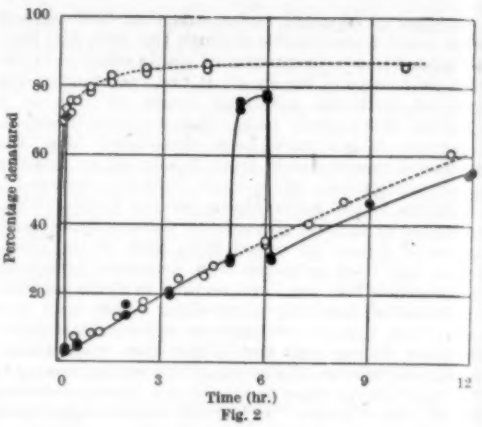

Fig. 2

The temperature dependence of β-lactoglobulin denaturation by urea is shown by Fig. 1, which shows the very large negative temperature coefficient for the initial stages of the denaturation. For the later part of the denaturation process the temperature coefficient is positive.

The denaturation at 0° C. is rapidly and nearly completely reversed if the temperature is increased. Fig. 2 shows the denaturation time-curves for experiments in which the temperature is changed. The dotted curves show the denaturation process at constant temperature, while the full-line curve shows the denaturation process in the following circumstances. The urea and protein solutions were mixed at 0° C.; after 6 min. the mixture was heated to 37·4° C. and was kept at this temperature for five hours, whereupon it was cooled to 0° C., kept at this temperature for one hour and again heated to 37·4° C.

The high denaturation-rate at 0° C. is already known from Fig. 1; the reversion of the denaturation upon heating is amazingly rapid. In this connexion it is interesting to note that heat denaturation of β-lactoglobulin can be reversed by cooling[3].

The shape of the curves of Fig. 1 seems to indicate that the denaturation process is composed of simultaneous or consecutive reactions, while Fig. 2 shows that at least one of the denaturing reactions goes to a temperature-dependent equilibrium between denatured and native protein. In these circumstances the mutual positions of the curves may be accounted for by assuming positive temperature coefficients for the partial reactions. The choice between the several possibilities for the paths of reactions must, however, wait until more experimental material is at hand.

The reversion of denaturation seems to be complete, since the reverted protein is crystallizable. This was shown in the following manner. The denaturation was allowed to proceed for 6 min. at 0° C. (70 per cent denatured), whereupon the solution was heated to 37·4° C. and kept at this temperature for 10 min. After addition of one volume of water, about 3 per cent of the protein was insoluble in the buffer-salt mixture. Slow addition of saturated ammonium sulphate solution to two-thirds saturation caused crystallization of practically all the protein (addition of trichloroacetic acid to the filtrate caused only a slight opalescence). The crystals were indistinguishable from those produced by the method of Sørensen and Sørensen[4].

It seems likely that the crystallized protein is identical with the starting material; a final identification cannot, however, be established without careful examination of other properties than the crystalline habit.

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[2] Clark, J. H., *J. Gen. Physiol.*, **27**, 101 (1943), and **28**, 539 (1943).
[3] Linderstrøm-Lang, K., Hotchkiss, R. D., and Johansen, G., *Nature*, **142**, 996 (1938).
[4] Sørensen, S. P. L., and Sørensen, M., *C.R. Lab. Carlsberg*, Sér. Chim. **23**, 7, 86 (1939).

THE NATURAL VEGETATION OF TRINIDAD

IN a work bearing this title*, Dr. J. S. Beard has given a comprehensive and interesting account of the vegetation of the untouched forest regions of the island of Trinidad, B.W.I. In general, this work follows the earlier survey of R. C. Marshall and brings to the notice of the reader literature which has contributed to a knowledge of the ecology of this region. The underlying practical reason for this study, namely, the correct utilization and conservation of the remaining areas of unalienated Crown land, follows a long period of *laisser-faire* during which there was no effective official policy and when, as in many other tropical regions, the harmful utilization of virgin areas was all too common.

The present survey is both thorough and readable. It gives a clear account of the uniquely interesting position of Trinidad—an outlier of the South American continent, rather than the southernmost member of the Antilles—and of the factors which enter into the ecological situation. It might almost be said that if what you want is an adequate introduction to the vegetation of tropical America, you should begin with Trinidad. The advantages are numerous. The island, roughly about the size of an English county, has a rich flora (upwards of 2,200 angiosperms), many being representative of the mainland. On the whole this flora is now sufficiently well known, and herbaria are available for consultation. The data of considerable soil surveys are also available: no less than twenty-three types have been enumerated, which for ecological purposes can be classed into three groups in terms of drainage—a conception of which much use has been made in Beard's studies. Other relevant data, topographical, geological and meteorological, are also at hand and are summarized in the present work.

The total of endemic species in the entire flora is estimated at 7 per cent—a low figure for an island flora. The evident close affinity of the Trinidad flora is with the rich adjacent South American region; affinities of a more remote kind with the flora of West Africa can also be traced.

The present work is chiefly concerned with the tree flora. Although a considerable part of the original forested area has been cleared for cultivation, much still remains in its native state, the influence of man being entirely local in nature. A check list of trees is followed by a classification of the plant communities. The six formations which are recognized, seasonal, dry evergreen, montane, intermediate, swamp and marsh formations, are based on climatic and edaphic factors. Each is treated in detail and illustrated by diagrams and some good photographs. Space does not permit of any account being given of this considerable section of the memoir: the overall result is, however, excellent, and the reader, and still more the visiting botanist, will be able, in a short space of time, to gain a real insight into the components of this rich and varied region.

In the concluding section the author analyses and discusses the relationships observed and the ecological conceptions which emerge. In particular, he is concerned with the correct application of certain terms—the names of the several floristic groups—and with concepts such as the nature of the climax. Of the climatic climax he writes as follows:

"In the tropics, studies have shown repeatedly that it is the moisture-supplying ability of the soil which is the most important consideration and this is not necessarily at all closely concerned with climate. The writer's classification of the formations into six series is based entirely on moisture relations which result from the interplay of the three factors of climate, topography, and soil. The ecosystem, in fact, is one and indivisible. Climate, however, is the only component factor of the ecosystem which for any given area is constant (or presumably more or less constant). Land-form and soil, and with them the vegetation, pass through young, mature, and senile stages of development. Within any climatic region or zone, therefore, at some point in the cycle of development a formation will appear which can be interpreted as the highest type of vegetation which can develop under the given climate, other environmental factors (land-form, soil) having at the same time developed the most favourable moisture conditions possible to them in the cycle. The writer believes this to be a more workable definition of the climatic climax.

"As so defined, the climatic climax will not necessarily be the highest type which can exist in the given climate, for such a type would only appear in the presence of ideally favourable conditions of soil and topography. This definition permits of the existence of more than one equivalent climatic climax within a given climate, according to differences in the land-form/soil complex."

A final section is devoted to a reconstruction of the palæo-ecology of the island. The author is to be congratulated on a valuable piece of work in which the reader's interest is sustained throughout.

C. W. WARDLAW

* Oxford Forestry Memoirs, No. 20, 1945. Pp. 152, with coloured map and 46 illustrations. (Oxford: Clarendon Press, 1946.)

TRAINING FOR CHEMISTS

THE Education Committee of the British Association of Chemists has recently published its suggestions on the education of chemists*, and though the report does not contain any strikingly novel proposals, it is full of sound sense and should be carefully studied in both academic and industrial chemical circles. The Committee points out that practically the whole of the industry of Britain is dependent on scientific control: a platitude, no doubt, to men of science, but a fact that still has to be emphasized, and emphasized repeatedly, for a general public to whom science is even yet an arcanum. To implement this control a steady and increasing flow of scientific men, and particularly chemists, is essential, and the Committee considers

* Education in Chemistry: the Teaching of Chemistry in Schools and the Training of Chemists and Chemical Technicians for Industry. (London: British Association of Chemists.) 2s. net.

the education of chemists under the headings of chemistry in schools, chemistry at the university and the technical college, the training of chemists and chemical technicians engaged in industry, and the recruitment and training of teachers of chemistry.

The report has little to say about the inherent value of science as part of a liberal education, confining itself to the bare assertion that the study of science is of direct cultural importance. This aspect could usefully have been treated more fully, for even to-day it remains true that in a great many schools science is regarded as on a lower educative plane than the so-called humanities. A strong lead from the British Association of Chemists would have found wide support from science masters and mistresses, and since the fundamental education of chemists is given in the schools, the tone should have been pitched high from the start. The report does, however, make many valuable observations on school science, especially the remark that there is sometimes too much insistence on 'the spirit of science' and too little on providing in an assimilable form an essential basis of facts and their relationship. This is a fully justified charge: the pendulum has, indeed, swung to the opposite extreme from the old South Kensington days, and university chemistry teachers have good reason to complain of the lack of factual knowledge shown by freshmen. Though the report does not specifically refer to it, one contributory cause of this situation, so far as chemistry is concerned, is the neglect of qualitative analysis in the schools: analysis admittedly requires a great deal of time, but it does make the student familiar with the materials of his craft.

On types of school, the report refers to the suggestion in the White Paper on Education that at eleven, and at thirteen, pupils should be allocated to one of the three kinds of secondary school—grammar, modern or technical. This suggestion is regarded as unsound, because no preference is shown by most pupils at these ages; instead, the Committee recommends that the three proposed types of school should be divisions of one multilateral institution under the general control of the same board of governors and arranged if possible on the house system. The chief advantage claimed for this system is a social one; it would help to prevent the development of superiority or inferiority complexes surrounding the type of child in a particular grade of school. The Committee agrees that there is a case for grouping pupils at about the age of thirteen into classes of differing intellectual abilities, but makes the very sound point that this grouping should be such as to allow those who learn quickly to make more rapid progress in a common curriculum than to divide children into classes taking widely different courses.

On the question of external school examinations, the Committee feels that some such test at School Certificate age should be maintained, since industry and society require some datum line on which they can base an initial estimate of educational attainment, and an internal standard must inevitably vary from school to school. The test should, however, be conducted in such a way as to yield an estimate of general intelligence rather than of an ability to reproduce set problems and books. After the school minimum leaving age, the Committee recommends for all pupils the continuation of a general course in certain compulsory subjects, including science, with a choice of others, such as languages, handicrafts, and so on. The basic subjects common to all would be English, science, mathematics, a modern language, history and geography, with the addition of Latin for potential science specialists if it has not been studied previously.

As to the Higher Certificate, the Committee feels, like so many of us, that the whole basis of the examination should be broadened, and that the certificate should not exempt the student from the first-year course at a university. Similarly, scholarship examinations should not be tests to discover how far candidates have already progressed towards their degree, but should be a means by which those most capable of profiting by further education on more specialized lines may be selected.

At the university and technical college, the report continues, the science student must have time to make contact with students in other faculties and sufficient leisure to follow some cultural interests. This would probably involve an increase from three years to four years in the normal pass degree course, and is particularly necessary in chemistry if the proper background to the subject is to be imparted.

Further suggestions by the Committee include closer co-operation between the universities and the chemical industry, a modification in the conditions of military service for undergraduates, the formation of training centres for technical grades, better prospects for junior employees, an improved financial standard of remuneration for chemists and the encouragement of well-qualified teachers. The report ends with an appeal to all the organisations now representing the craft of chemistry to make a common approach to the whole subject.

E. J. Holmyard

ECHINODERM FAUNA OF AUSTRALIA

Dr. Hubert Lyman Clark's large work, "Echinoderms from Australia", was reviewed in *Nature* of September 24, 1938. That review and the obituary notice of Dr. Clark in *Nature* of September 20, 1947, show how many and how important were his contributions to the knowledge of Australian echinoderms. He had made them his peculiar province; it is fitting that they should be the subject of his *chef-d'œuvre*, "The Echinoderm Fauna of Australia: its Composition and its Origin"*, which was published in 1946 and has now reached Great Britain. For it he received on his deathbed the award of the Australian Clarke Medal.

Part 1, which is by far the greater part of the volume, is an account of all the echinoderms, living or extinct, which are known from Australia. There are keys to all orders, families, genera and species; and, under each species—and there are nearly nine hundred of them—notes on synonymy, range, occurrence, habitat, habits, colour, variation and food so far as they are known. There are no illustrations, since nearly all the species have been figured elsewhere, and references to those figures are given.

Part 2 is a discussion of the composition and origin of the Australian echinoderm fauna. Its most characteristic feature is the predominance of East Indian forms and influences, so that there can be no doubt it is derived from there. It appears to have

* Carnegie Institution of Washington, Publication No. 566. The Echinoderm Fauna of Australia; its Composition and its Origin. By Hubert Lyman Clark. Pp. iv+567. (Washington, D.C.: Carnegie Institution, 1946.) 4 dollars.

come along two paths, one on either side of the land-bridge which once spanned what is now the Torres Strait; for the faunas of the north coast and of east Queensland bear each a different facies, having not yet completely commingled. The farther away one goes from Torres Strait, whether south by Queensland and west along the Bight, or north by Darwin and so around to Perth, the more characteristic the fauna becomes, until in the south-western corner it is nine-tenths endemic.

The conclusion that the Australian echinoderm fauna is East Indian in origin is preceded by successive and detailed comparisons with the echinoderm faunas of all surrounding lands—of Antarctica, Kerguelen, Mauritius, South Africa and so on north-about to New Zealand. Dr. Clark believed that because of their "relatively sedentary habits, their aversion to fresh or even brackish water, the brevity or complete absence of a free-living larval life, and the usually small bathymetric range, echinoderms are remarkably suitable material for studying changes in shore line or the relation of land masses to each other". Where in distant faunas he finds similarities to that of Australia he attributes them, for the most part, to a common source in the East Indian fauna. A number of perplexing forms, like, for example, the sea-urchin *Dermechinus*, which occurs off the southern tips of America, Africa and Australia, cannot be so explained; but Dr. Clark concludes "that only a desperate desire to validate the Wegener hypothesis can find in the echinoderm fauna of Australia any evidence that it is at all closely related to that of South Africa or even of New Zealand". D. DILWYN JOHN

TOWARDS AN INTERNATIONAL PHARMACOPŒIA

THE first meeting was held at Geneva during October 13–17 of the Expert Committee on the Unification of Pharmacopœias of the World Health Organisation. There were present Prof. H. Baggesgaard Rasmussen (Denmark), Prof. E. Fullerton Cook (United States), Prof. I. R. Fahmy (Egypt), and Dr. C. H. Hampshire (Great Britain); Prof. R. Hazard (France) was prevented by illness from attending. The members were welcomed, in the name of the Executive Secretary, by Dr. R. Gautier, who said that the duties of the Committee would be to continue the work on the unification of pharmacopœias which had been begun by the Technical Commission of Pharmacopœial Experts of the League of Nations. Dr. C. H. Hampshire was elected chairman.

The Committee accepted the general principles expressed in the Interim Report of the previous Commission published in 1945, and approved the monographs contained therein, subject to consideration of any comments which might be received later. The intention that the recommendations of the Committee should take the form of an International Pharmacopœia was approved, the scope to be limited in the first place to drugs considered to be essential in medical practice. It was understood that such an International Pharmacopœia could have no authority in any country until it had been adopted by that country.

A list of 534 drugs was considered and 244 were selected for immediate attention. It was decided that monographs on the drugs for which the Committee on Biological Standardization had provided standards should be included. Thirty draft monographs were completed, making with those in the interim report a total of seventy-two.

The preparation of drafts of monographs, general notices and appendixes, and of reports on special subjects was allocated among the members present, who also undertook the necessary experimental work. Arrangements were made for special reports on such subjects as alkaloidal assays, boiling points and melting points, fineness of powders, and the sterilization of injectable materials.

In view of the fact that the place of galenicals in medicine had been largely taken by the new synthetics, alkaloids and injectable materials, the Committee decided not to re-establish the Reference Sub-Committee on Galenical Pharmacy, appointed by the previous Commission. The possibility of establishing an international procedure for naming new drugs at an early stage of their introduction into medicine, and the standardization of surgical ligatures, sutures and dressings, were also discussed and reserved for future consideration.

In view of the volume of work to be undertaken and of the necessity for widening the international basis of the work, the Committee recommended that at least three additional members should be appointed and that a unified secretariat with specialized staff should be formed.

FORTHCOMING EVENTS

Monday, January 5

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. J. Bunker: "Some Scientific Aspects of Beer".

Tuesday, January 6

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. Clifford Heyes and Mr. J. Brierley: "Airfield Lighting".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Capt. G. T. Smith-Clarke: Chairman's Address.

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. S. W. Carpenter: "Automatic Welding".

Wednesday, January 7

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the ASSOCIATION OF PUBLIC LIGHTING ENGINEERS, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. E. J. Stewart: "The Lighting of Housing Estates".

Thursday, January 8

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the National Hospital, Queen Square, London, W.C.1), at 4.30 p.m.—Prof. H. Hartridge, F.R.S.: "The Use of Supersonic Sound by Animals"; Dr. C. S. Hallpike and Miss M. R. Dix: "Pure-Tone Audiometry in Young Children, a New Technique" (Film and Demonstration); Dr. Dennis Fry: "Tone Deafness".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the LOCAL SECTIONS of the SOCIETY OF CHEMICAL INDUSTRY and the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Dr. M. P. Applebey: "Crystallisation of Fertilisers".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. J. O. Scott: "Roads and their Riding Qualities".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "Structural Relationships in the Natural Unsaturated Higher Fatty Acids".

Friday, January 9

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Dr. A. Roberts: "Education for Management in the Textile Industry".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. F. Armitage and Mr. J. J. Sleightholme: "Further Developments in Styrene Co-Polymers".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. D. R. Davies: "Shock Waves in Air at Very High Pressures"; Mr. D. C. Pack, Mr. W. M. Evans and Mr. H. J. James: "The Propagation of Shock Waves in Steel and Lead".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. E. Schmidt: "Design of Contra-Flow Heat Exchangers".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. J. M. J. Esteves: "Contact Resins".

SHEFFIELD METALLURGICAL ASSOCIATION, METHODS OF ANALYSIS GROUP (at 198 West Street, Sheffield), at 7 p.m.—Mr. E. J. Vaughan: "The Spekker—What it Is and How it Works", Part 1.

INSTITUTION OF THE RUBBER INDUSTRY, LEICESTER SECTION (at the Bell Hotel, Humberstone Gate, Leicester), at 7.30 p.m.—Mr. G. A. Shires: "Libraries and the Handling of Technical Information in the Rubber Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESIDENT INSTRUCTOR AND LECTURER IN AGRICULTURE at the Training Centre for Ex-Service men, Pulborough—The Secretary, West Sussex War Agricultural Executive Committee, County Hall, Chichester (January 10).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. No. A.337/47) to be responsible for radiation survey work and health radiation measurements, and a SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (Ref. No. F.773/47) to be concerned with problems of transportation and handling of chemicals, at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (January 10).

JUNIOR PHYSICIST—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (January 16).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (January 17).

ANALYTICAL CHEMISTS (male or female) for works in N.E. Scottish town—The Ministry of Labour and National Service, Room 669, York House, Kingsway, London, W.C.2, quoting F.515/47A (January 20).

LECTURER IN CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (January 24).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Sheffield (January 31).

WATSON-WATT CHAIR OF ELECTRICAL ENGINEERING in University College, Dundee—The Secretary, The University, St. Andrews (January 31).

DIRECTOR OF THE SUGAR MILLING RESEARCH INSTITUTE (Natal University College)—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (February 14).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University College, Southampton (February 15).

UNIVERSITY DEMONSTRATOR IN AGRICULTURE—The Secretary, School of Agriculture, Cambridge (February 21).

CHAIR OF APPLIED MATHEMATICS at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (February 28).

ASSISTANT PROFESSOR and an ASSOCIATE PROFESSOR OF PSYCHOLOGY—The Bursar, McGill University, Montreal, Canada (March 1).

SENIOR LECTURER IN THEORETICAL PHYSICS—The Secretary of Faculties, University Registry, Oxford (March 15).

PRINCIPAL SCIENTIFIC OFFICER, Empire Potato Collection, Cambridge—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (April 1).

I.C.I. RESEARCH FELLOWSHIPS IN CHEMISTRY or PHYSICS, or some allied subject such as BIOCHEMISTRY, COLLOID SCIENCE, CHEMOTHERAPY, PHARMACOLOGY, METALLURGY or ENGINEERING—The Registrar, The University, Liverpool (April 30).

EXPERT IN SOAP MANUFACTURE, Department of Commerce and Industries, Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17602.

FORESTRY SURVEYOR for Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18180.

LECTURER or ASSISTANT LECTURER (man) IN COLONIAL SOCIAL SCIENCE—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2.

FISHERIES OFFICERS (2) in Uganda—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

MICROANALYST—Sir Norman Haworth, F.R.S., Chemistry Department, The University, Birmingham 15.

PHYSICAL CHEMIST—The Secretary, British Hat and Allied Feltmakers Research Association, 12 St. Peter's Square, Stockport, Cheshire.

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

LABORATORY ASSISTANT IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, University College London, Gower Street, London, W.C.1, quoting Biochemistry/1.

DESIGN ENGINEERS, DESIGN ENGINEERS (Instruments), PLANNING AND PROGRESS ENGINEERS, ESTIMATING ENGINEERS, BUYING ENGINEERS, ELECTRICAL ENGINEERS, POWER ENGINEERS, STANDARDS ENGINEERS, CIVIL ENGINEERS, and TECHNICAL ENGINEERS—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

LECTURER IN GEOGRAPHY—The Registrar, University College, Exeter.

SOIL LABORATORY ASSISTANT for Public Works Department, Government of Northern Rhodesia—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18396.

ASSISTANT INSPECTOR OF SCIENTIFIC SUPPLIES by the India Store Department—The Office of the High Commissioner for India, India House, Aldwych, London, W.C.2, quoting S.965/46.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, No. 591, Vol. 232: The Pallial Organs in the Aspidobranch Gastropoda and their Evolution throughout the Mollusca. By C. M. Yonge. Pp. 443–518. (London: Cambridge University Press, 1947.) 12s. 6d. [95

Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences, No. 818, Vol. 240: The Earth's Magnetic Field in Southern Africa at the Epoch, 1 July 1933. By E. N. Grindley. Pp. 251–294. (London: Cambridge University Press, 1947.) 10s. [96

World Power Conference. Annual Report, 1946. Pp. 15. (London: World Power Conference, 1947.) [96

World Power Conference. Reports on Fuel Economy since 1939. Argentine National Committee. Pp. 6. 6d. net. Australian National Committee. Pp. 10. 6d. net. Report for Austria. Prepared by the Austrian Ministry of Trade and Reconstruction. Pp. 4. 4d. net. Czechoslovakia National Committee. Pp. 4. 4d. net. Report for Germany. Prepared under the auspices of the Allied Control Commission for Germany (B.E.). Pp. 8. 6d. net. (London: World Power Conference, 1947.) [96

Institute of Fuel. Report of the Council for the Year 1946. Pp. 12. (London: Institute of Fuel, 1947.) [96

Oliscoil na h-Éireann: National University of Ireland. Calendar for the Year 1945. Pp. x + 308 + 910. (Dublin: National University of Ireland, 1945.) [125

Other Countries

United States Department of the Interior: Geological Survey. Professional Paper 205-D.: Late Mesozoic and Early Cenozoic History of Central Utah. By Edmund M. Spieker. (Shorter Contributions to General Geology, 1943–45). Pp. iii + 117–162 + plates 18–25. 15 cents. Professional Paper 206: Upper Cretaceous Foraminifera of the Gulf Coastal Region of the United States and adjacent Areas. By Joseph A. Cushman. Pp. iii + 242 + 66 plates. 1 dollar. Professional Paper 207: Geology and Paleontology of Palos Verdes Hills, California. By W. P. Woodring, M. N. Bramlette and W. S. W. Kew. Pp. v + 146 + 37 plates. 1·50 dollars. Professional Paper 210-A: Tertiary Foraminifera from St. Croix, Virgin Islands. By J. A. Cushman; with a Note on the Geology, by D. J. Cederstrom. (Shorter Contributions to General Geology, 1946.) Pp. ii + 18. 20 cents. Professional Paper 210-B: A Pennsylvanian Florule from the Forkston Coal in the Dutch Mountain Outlier, Northeastern Pennsylvania. By Charles B. Reed. (Shorter Contributions to General Geology, 1946.) Pp. ii + 17–28 + 2 plates. 15 cents. (Washington, D.C.: Government Printing Office, 1946.) [86

United States Department of the Interior: Geological Survey. Water-Supply Paper 986: Water Levels and Artesian Pressure in Observation Wells in the United States in 1943. Part 1: Northeastern States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 290. 50 cents. Water-Supply Paper 1001: Surface Water Supply of the United States, 1944. Part 1: North Atlantic Slope Basins. Pp. x + 634. 1.25 dollars. Water-Supply Paper 1002: Surface Water Supply of the United States, 1944. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. ix + 552. 1 dollar. Water-Supply Paper 1005: Surface Water Supply of the United States, 1944. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. ix + 422. 70 cents. Water-Supply Paper 1006: Surface Water Supply of the United States 1944. Part 6: Missouri River Basin. Pp. viii + 473. 75 cents. Water-Supply Paper 1008: Surface Water Supply of the United States, 1944. Part 8: Western Gulf of Mexico Basins. Pp. vi + 311. 45 cents. Water-Supply Paper 1012: Surface Water Supply of the United States, 1944. Part 12: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vi + 261. 45 cents. (Washington, D.C.: Government Printing Office, 1946.) [95

Kungl. Sjökarteverket, Stockholm. Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1944. Von Sven Åslund. Pp. 30. Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovö (Stockholm) im Jahre 1945. Von Sven Åslund. Pp. 30. Jordmagnetiska Publikationer, Nr. 13: Magnetic Measurements on the *Kompass* in the Baltic Sea, 1938. By Gustaf S. Ljungdahl. Pp. 21 + 5 plates. Jordmagnetiska Publikationer, Nr. 14: The Magnetic Homogenity of Testing Grounds for Investigation and Compensation of Airplane Compasses. By Nils Amboit. Pp. 9. (Stockholm: Kungl. Sjökarteverket, 1940–1947.) [95

Ceylon. Part 4: Education, Science and Art (F). Administration Report of the Director of National Museums for 1945. By P. E. P. Deraniyagala. Pp. F.8. (Colombo: Government Record Office, 1946.) 10 cents. [86

Catalogues

Polaroid Laboratory Products. Pp. 20. (New York: Pioneer Scientific Corporation, 1947.)

Edizioni di Cultura Libraria. (No. 1.) Pp. 24. (Firenze: Leo S. Olschki, 1947.)

Catalogue of Medical, Surgical, Nursing, Dental and Scientific Books. Pp. 72. (Edinburgh: E. and S. Livingstone, Ltd., 1947.)